محاضرات الهندسة المدنية

المرحلة الرابعة

دفتر كونكريت – ملون

اعداد وتصوير

ابوالقاسم الدراجي

لا تجعلها تقف عندك انشرها للطلبة الاخرين ولك الاجر

Facebook : https://www.facebook.com/abualqasimrahem

Telegram: https://t.me/abualqasimaldarraji

Email : abualqasimrahem@yahoo.com

Mobile : 009647709204269

concrete

رابع مدني

2016 – 2015

دفتر

مكتبة الناسخ
كلية الهندسة
استنساخ

6/10/2015

رابع مدني / Concrete

مكتبة الناسخ كلية الهندسة استنساخ - قرطاسية - هدايا

Reinforced Concret designe

Syllabus :-

* Types of Slabs.
* design of one-way Slab.
* design of two-way Slab.
* General concept of ACI code.
* Direct design method.
* min. Slab thickness of two way Slab.
* Total Static Moment in flat Slab.
* Shear in Slab System with beam.
* Shear Strength in flat plate and flat Slab.
* Transfer of moment at columns.
* yeild line theory.
* prestressed concrete.
* crack width.
* deflection
* design of Stair case.

Text Book

Design of concret Structures by the Nilson David Darwin and oharels W. Dolan.

Other Refrence 8—

* Reinforced Concret Machines and design by Jomes K weight and Jams G. Macgregor.

* ACI code (318 14-11)

* ACI SCE (gmmitte - 421)

* Building design and Construction Hand Book (by Frederick S. Merritt and Jonathar T. Ricketts)

* Mannual for design by reinforced Conc. building. Intitnte of Structure Engineering.

* Structure detailes in conc. M.Y. Bangash.

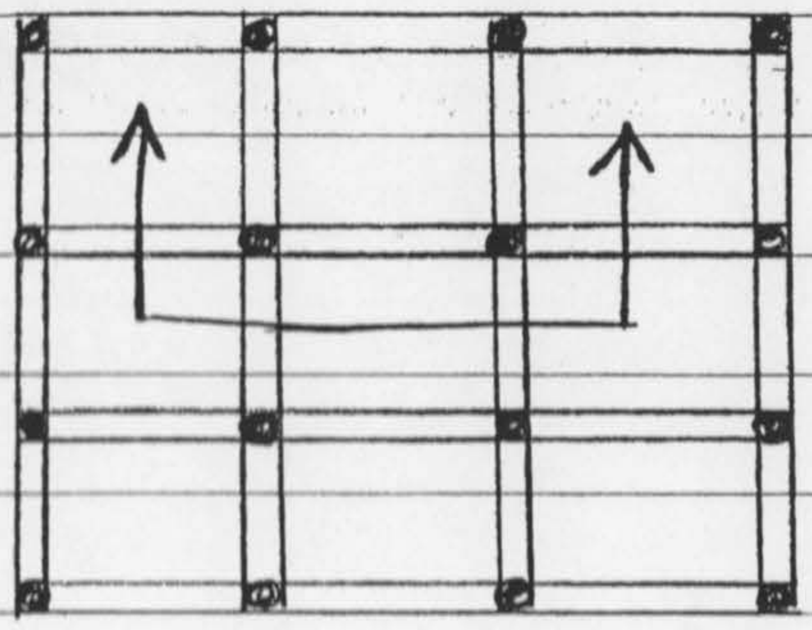
اللهم إني استودعتك ما قرأت وما حفظت وما تعلمت فرده إلي عند حاجتي إليه

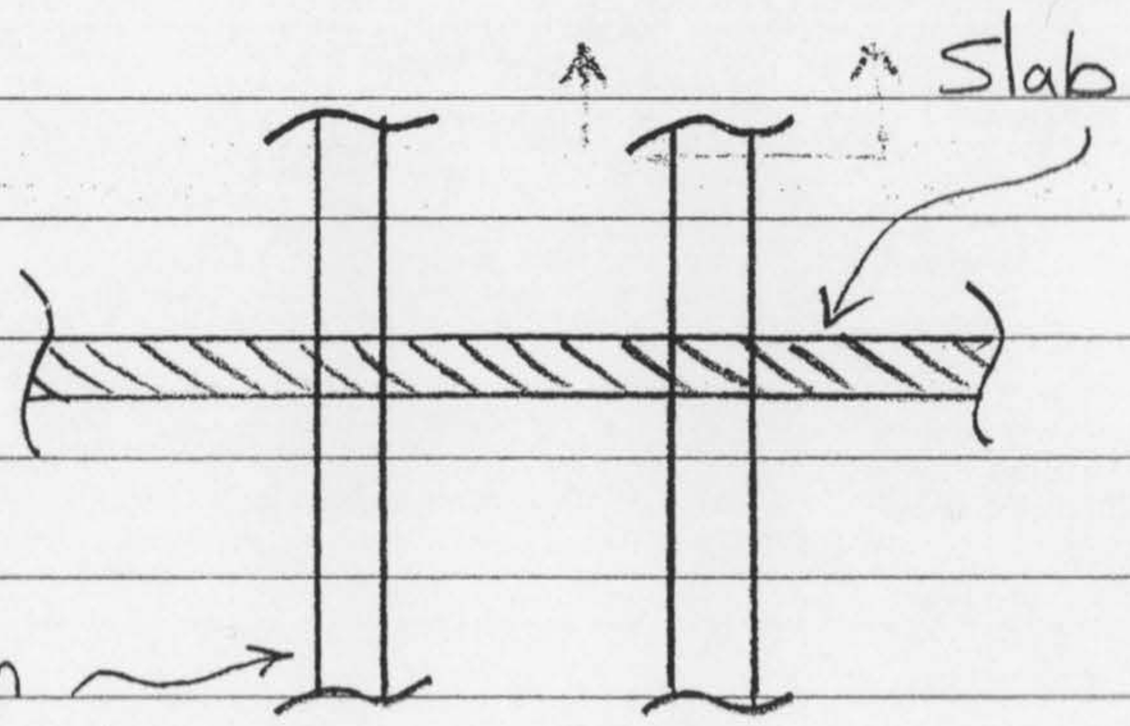
الموضوع:

التاريخ: 13 / 10 / 2015

Types of two way Slabs

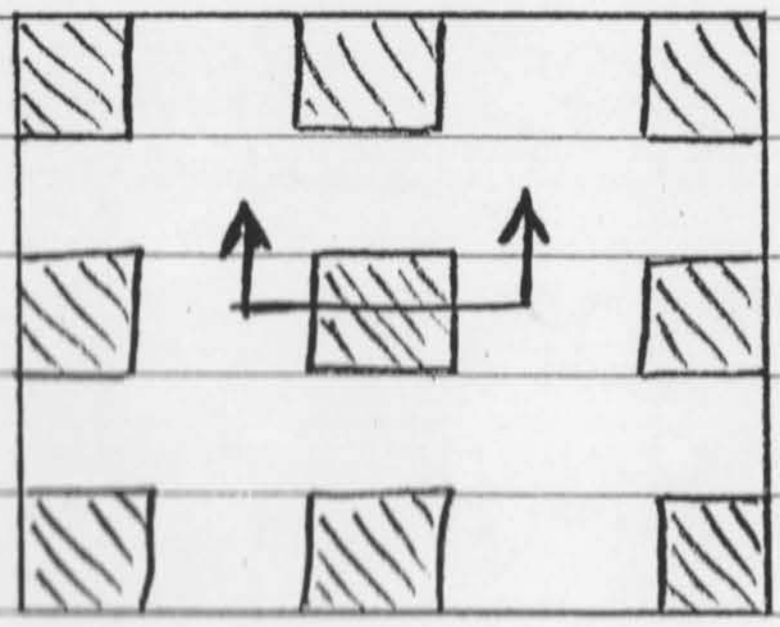
1_ Slab beam floor system.



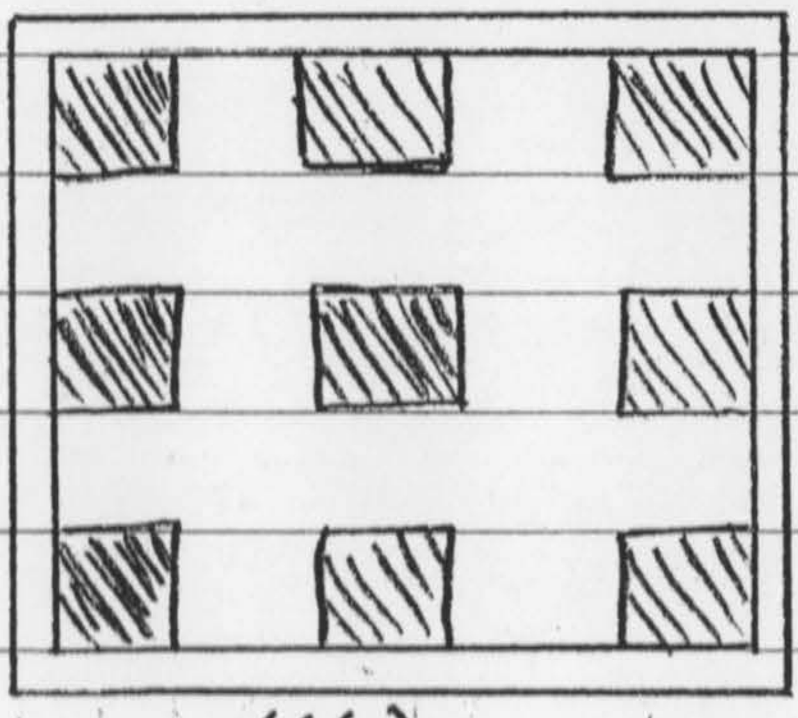


2_ Flat plate (No interior beam)

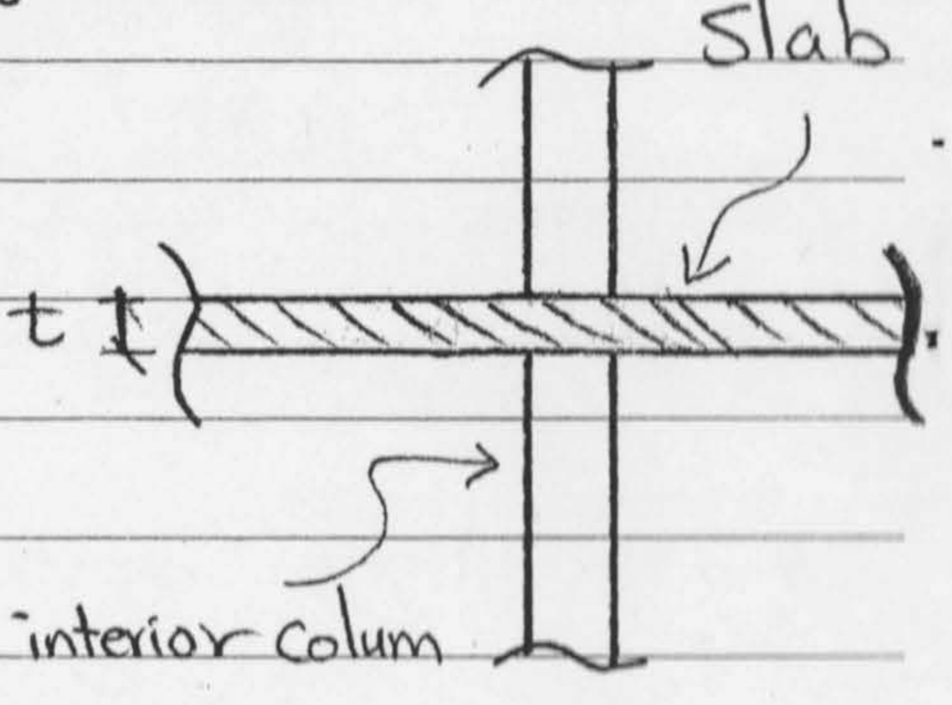
i) without edge beam ii) with edge beam.



(i)

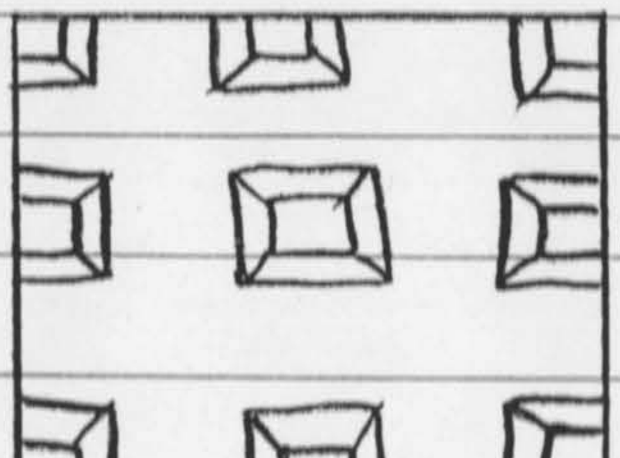


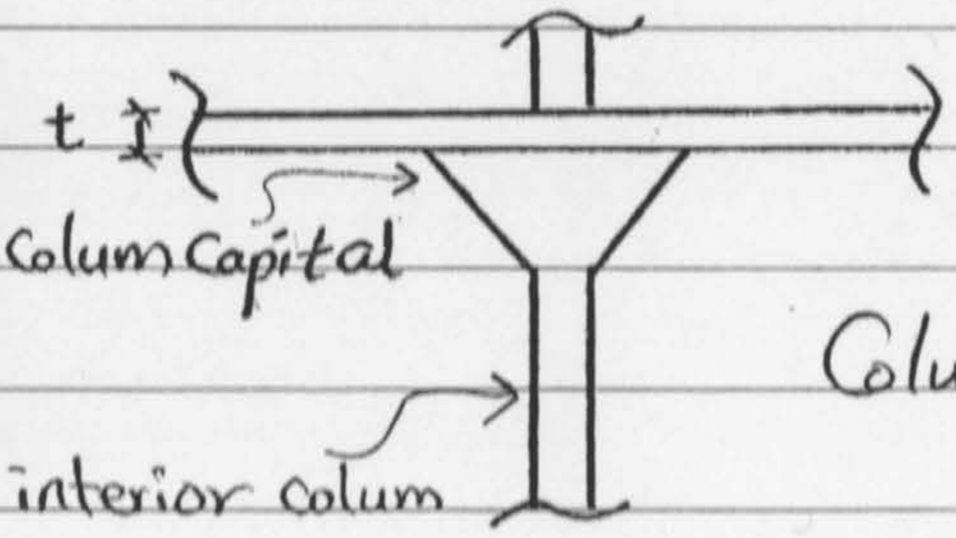
(ii)

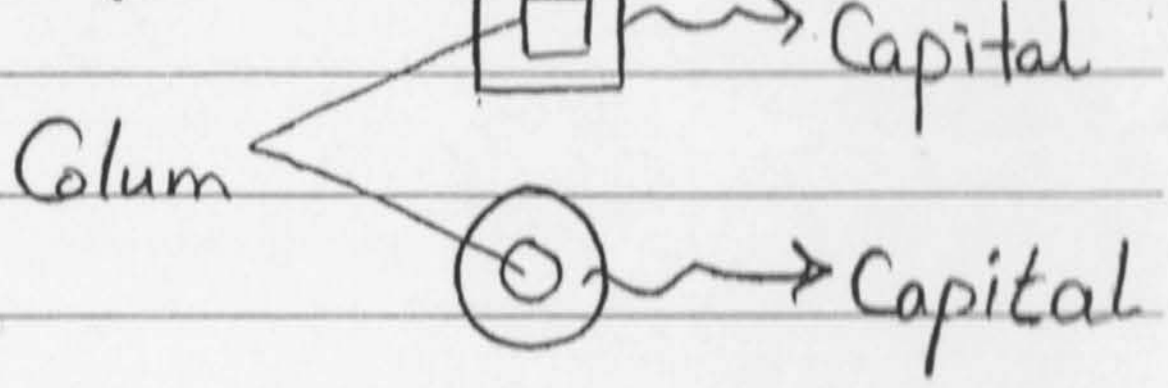


3_ Flat Slab (No interior beam)

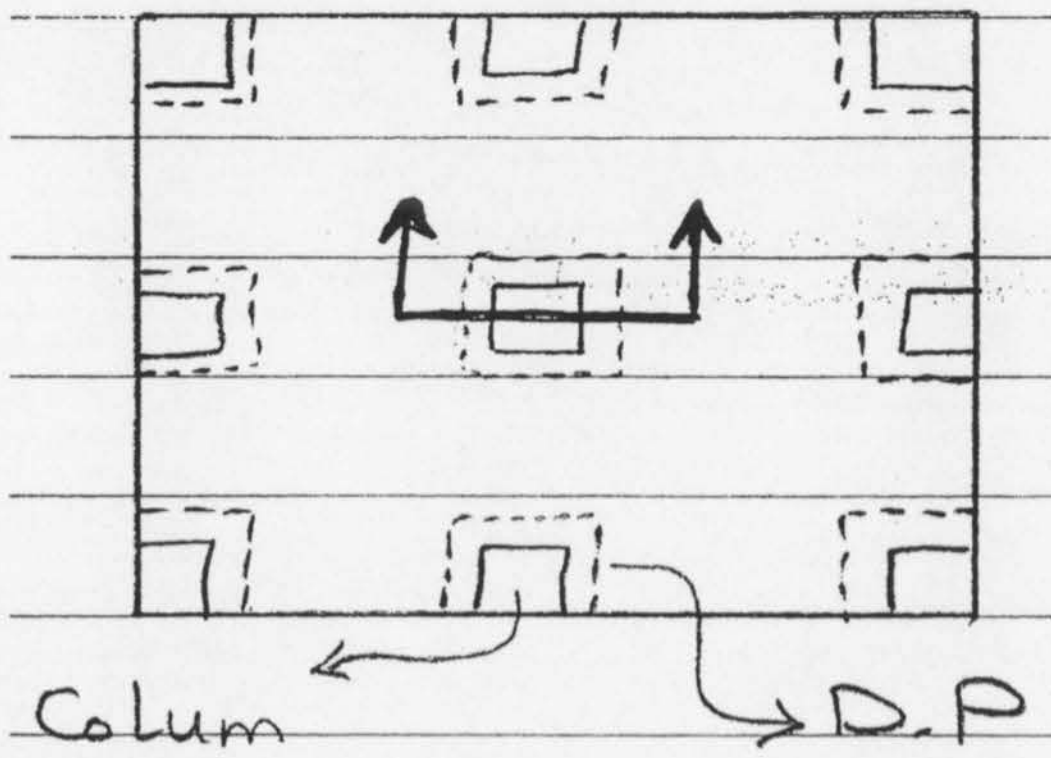
i) with Colum capital

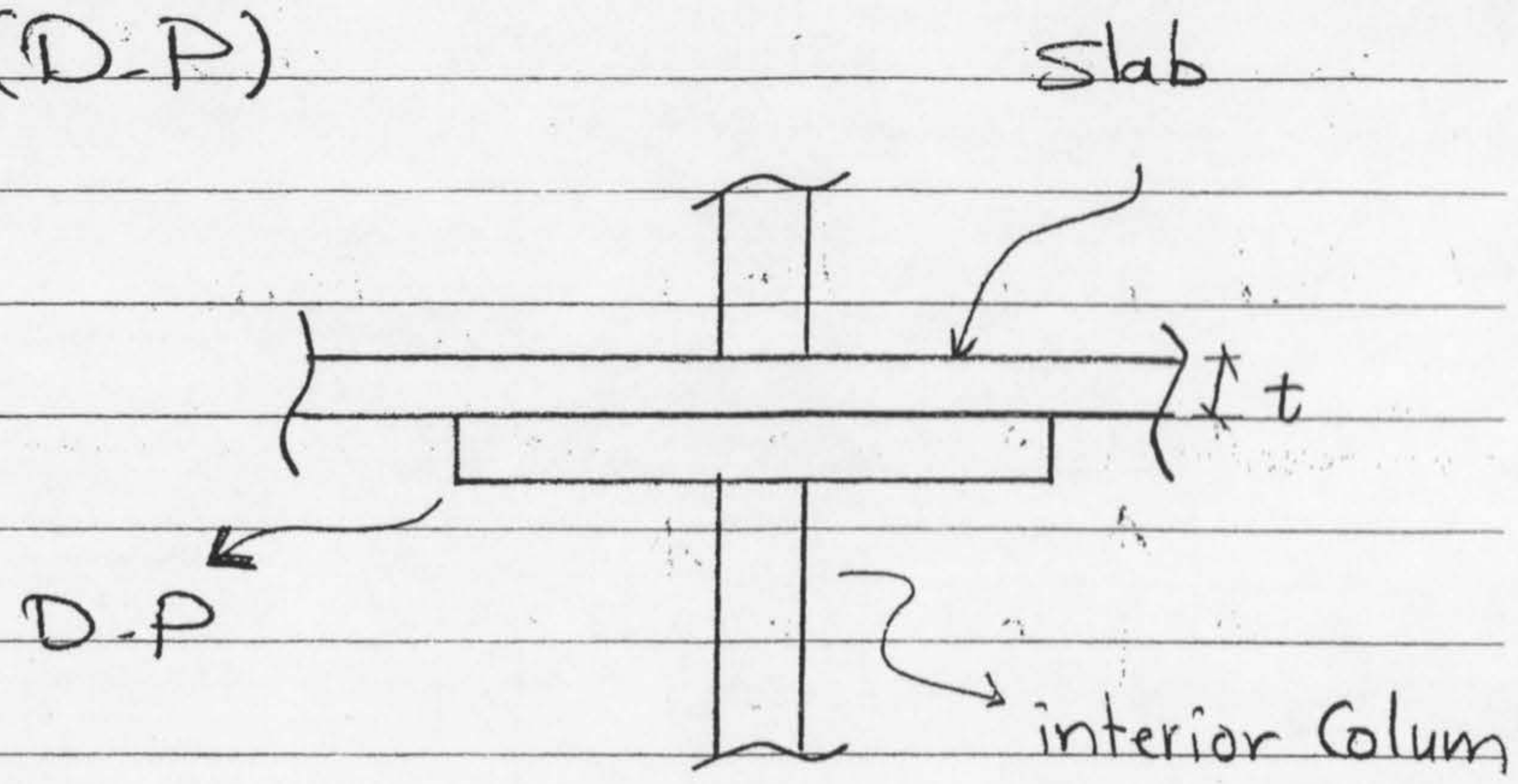




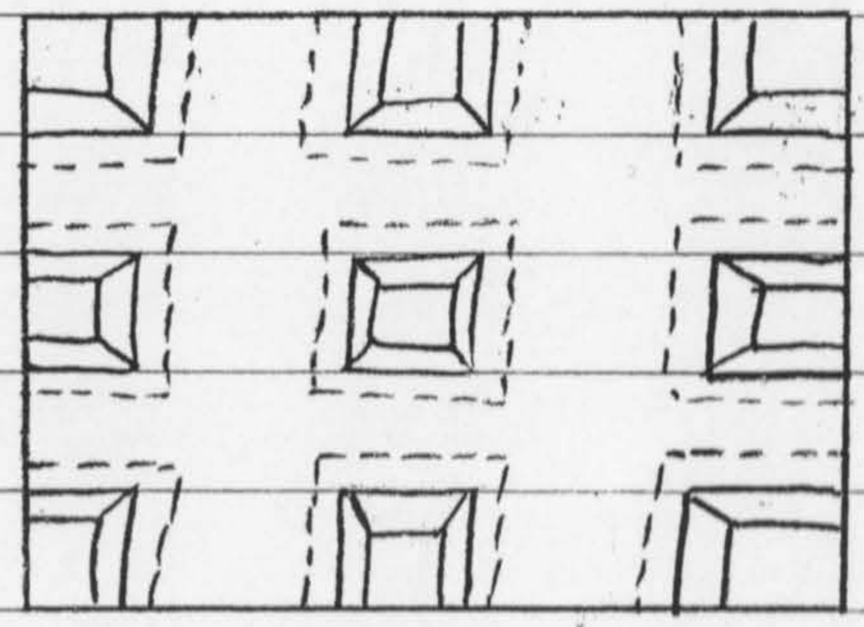


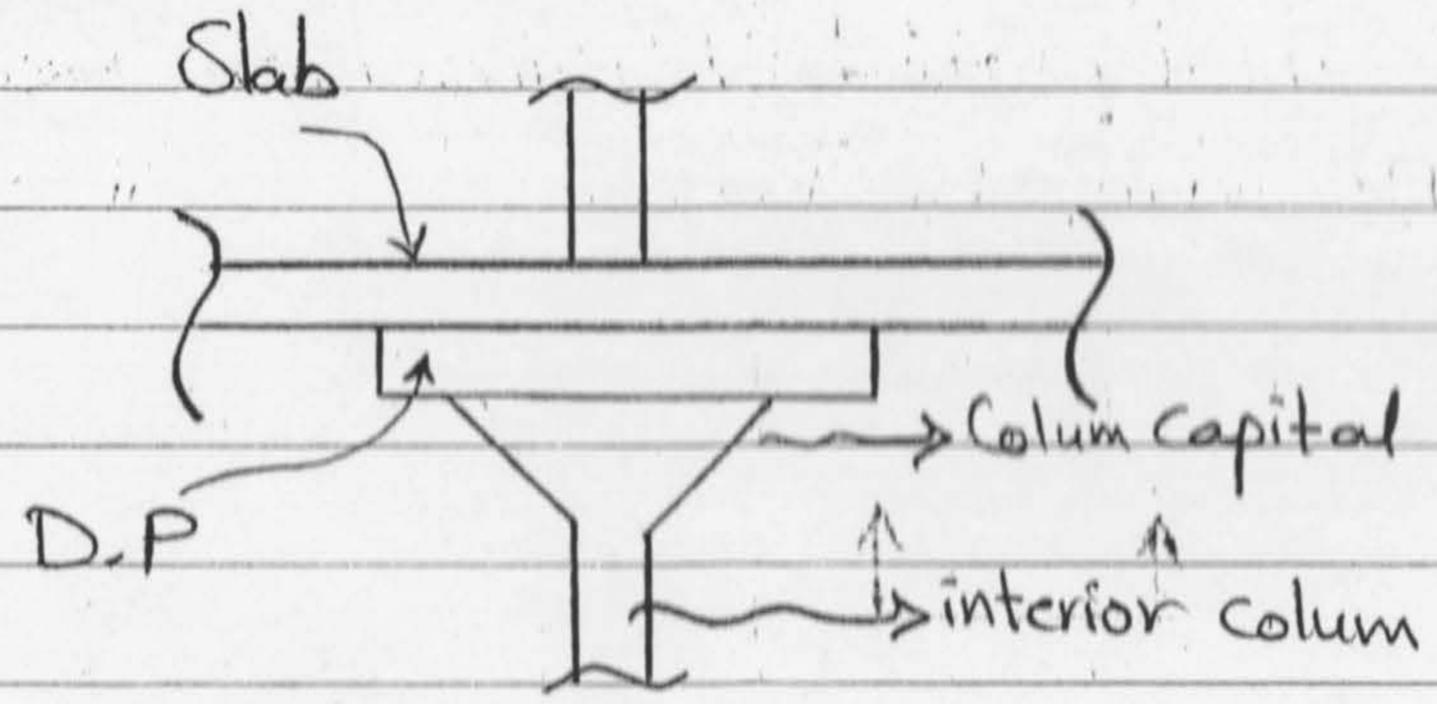
ii) With drop panel (D-P)





iii) with Colum capital and (D-P)

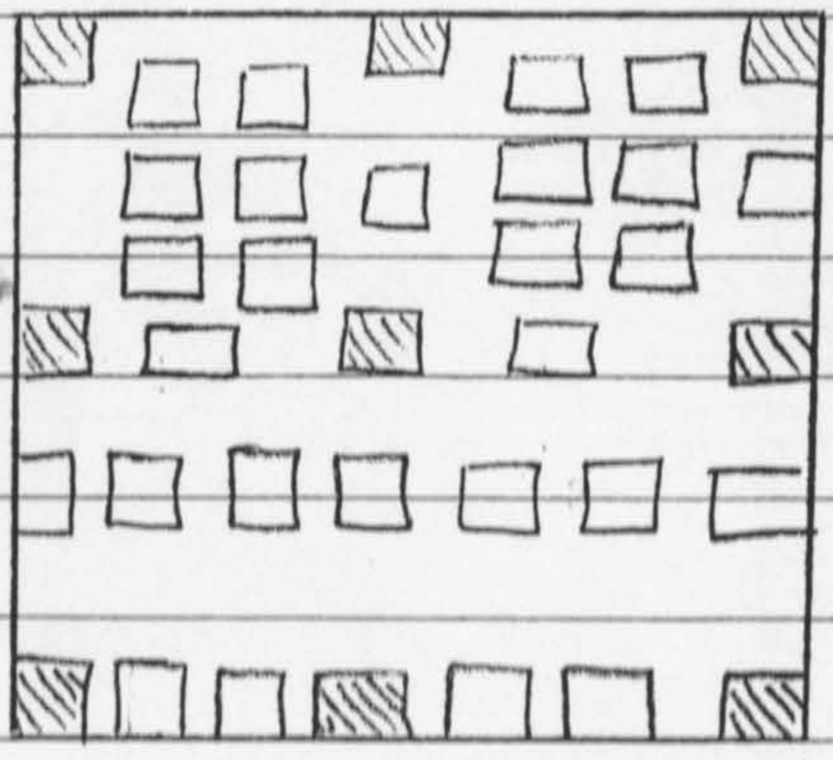


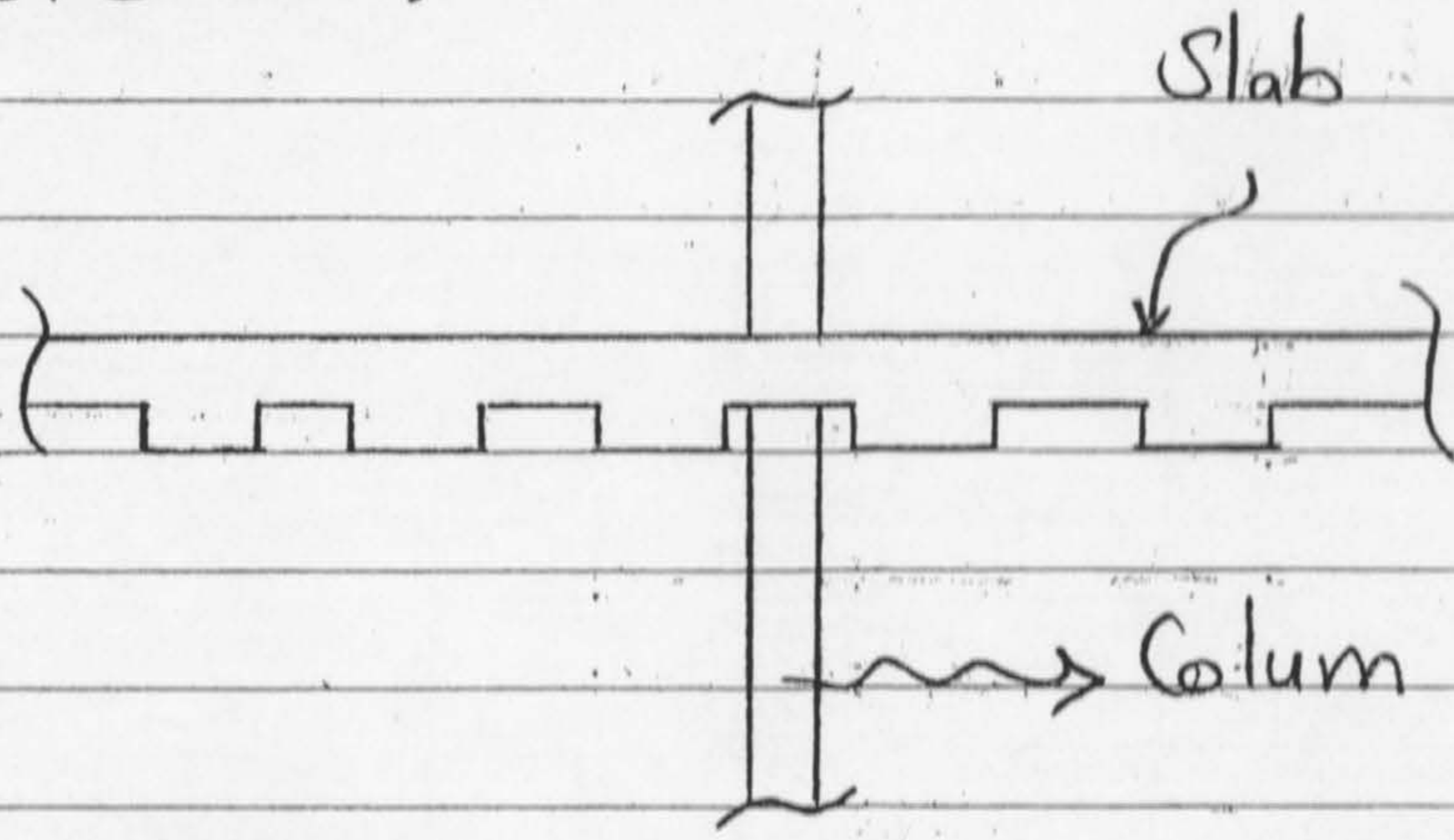


ابعادة توصل الى (10 m)

4- Two-way Joint (wafle Slab)

ابعادة توصل كـ (12 m)



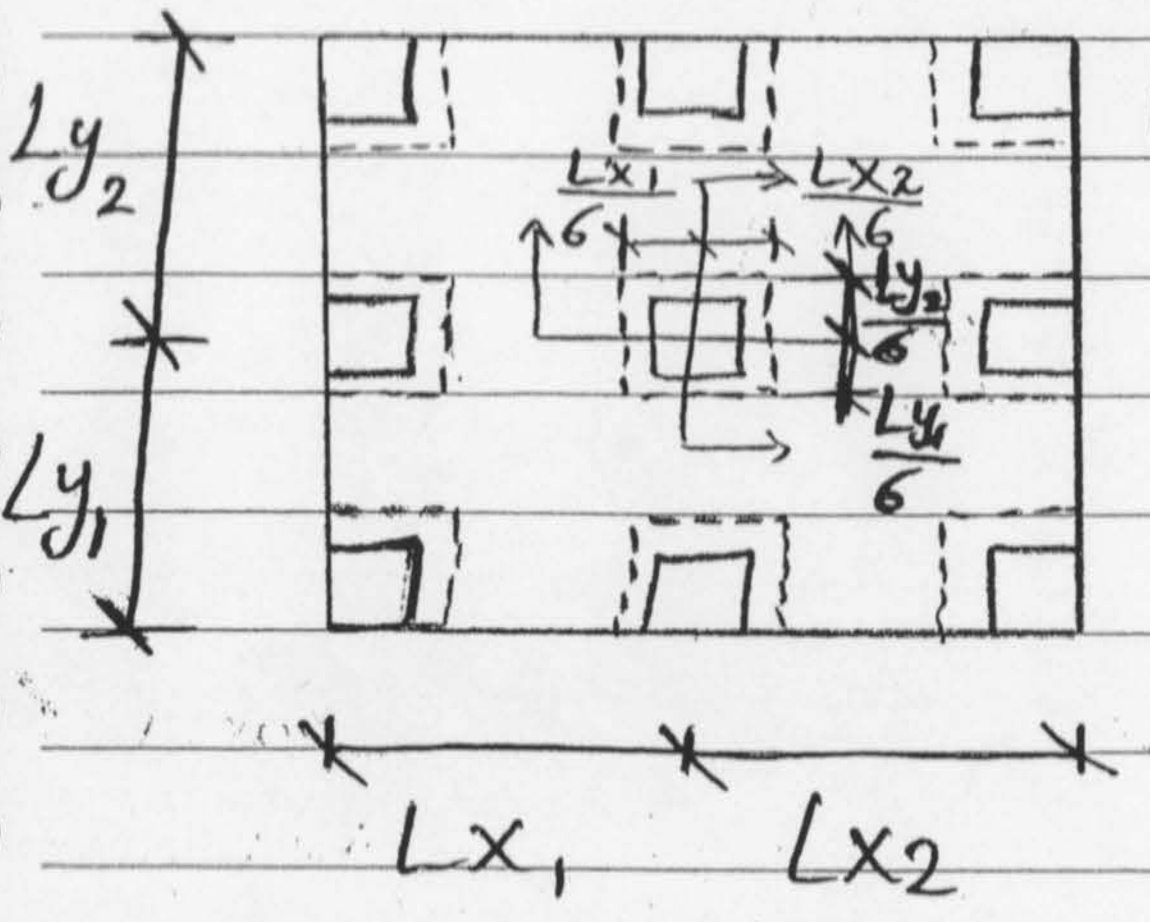


شروط الـ (Two way)

① $\frac{L}{S} = \frac{\text{الطول}}{\text{العرض}} < 2$

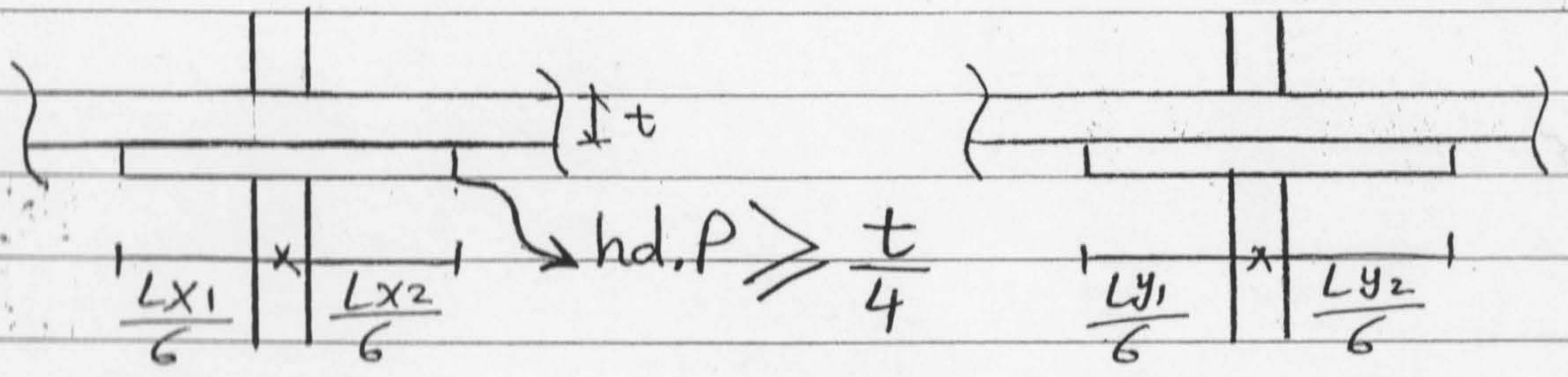
② لازم أقل شي يكون مستند على اكثر من مستندين.

Drop Panel (D.P)

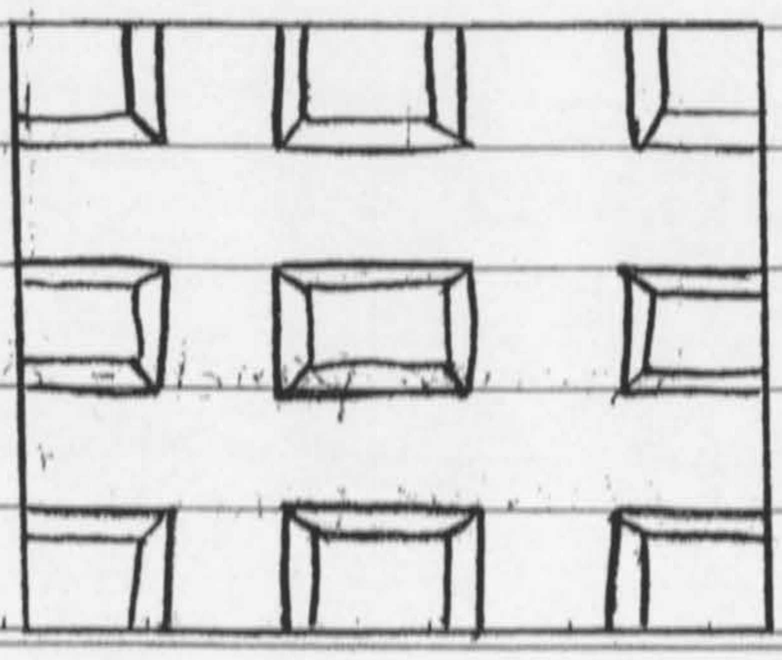


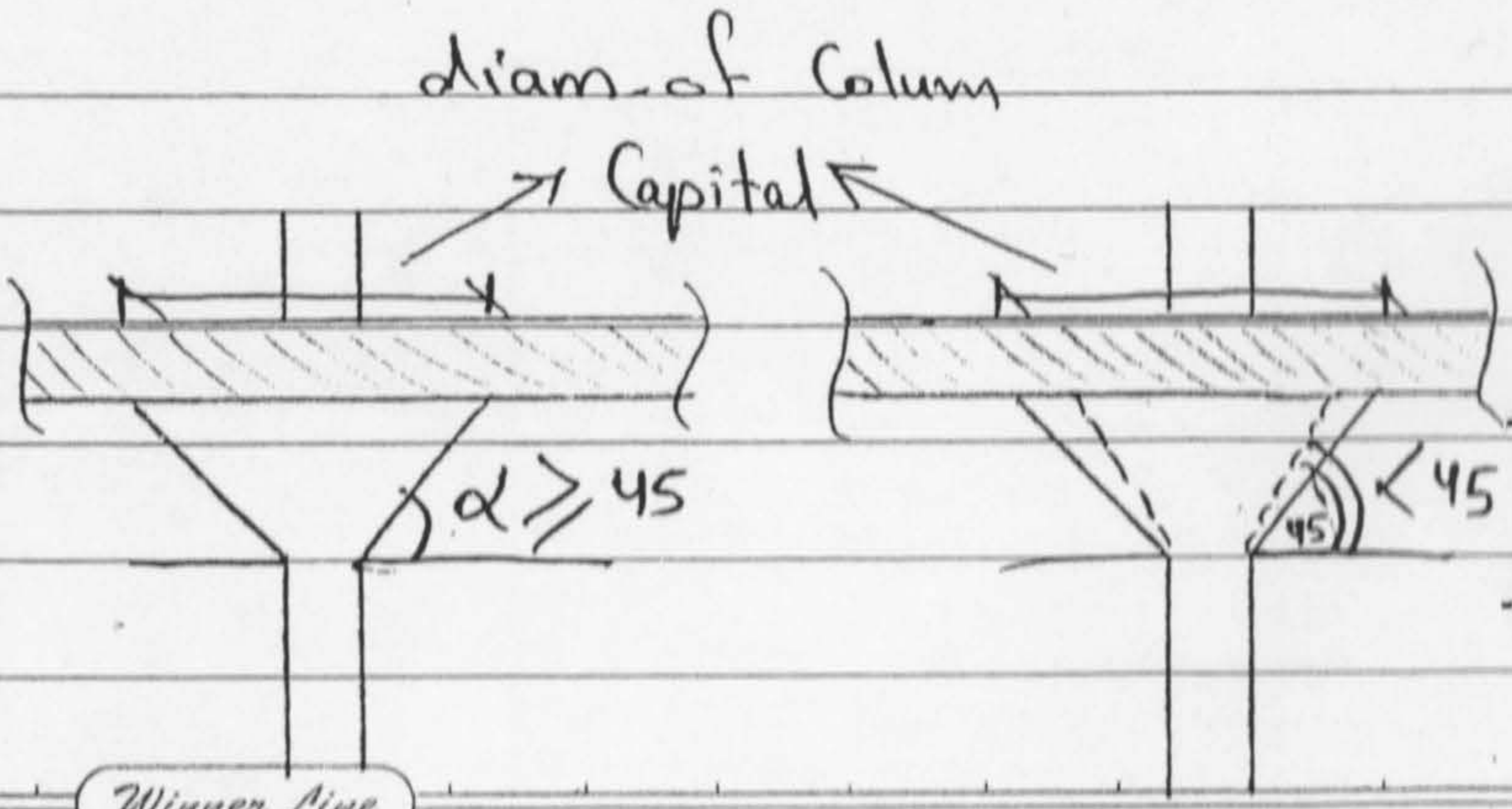
① سمك D.P أكبر من سمك (Slab/4)

② ابعاد الـ D.P
تساوي بعد بين سنتر الكولومات على 6
أو أكثر اذا أقل لا تعتبر D.P



Colum Capital





ملاحظة ::

* Column Capital جزء من الـ Column

* الـ drop panel جزء من الـ Slab

note ::

في Colum Capital لازم تكون الزاوية (45) لأن اذا كان أصغر يكون غير فعّال.

Minimum Slab thickness of two way slab.

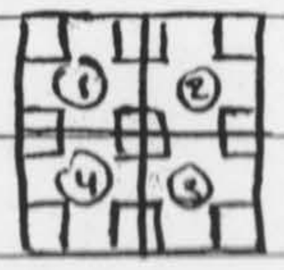
(1) without interior beam   الـ Flat slab بدون D.P

flat slab, flat plate الـ [illegible]

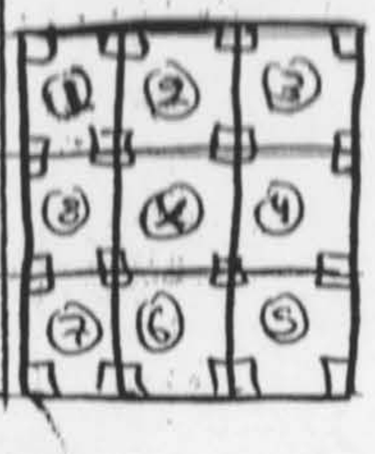
موجود بالمذكرة

fy	without D.P			with D.P		
	Exterior panel		interior panel	Exterior panel		interior panel
	No edge beam	with edge beam		No edge beam	with edge beam	
300	$\frac{Ln}{33}$					
420						
520						

الـ Panel هي اللي تكون الجهة حافة خارجية



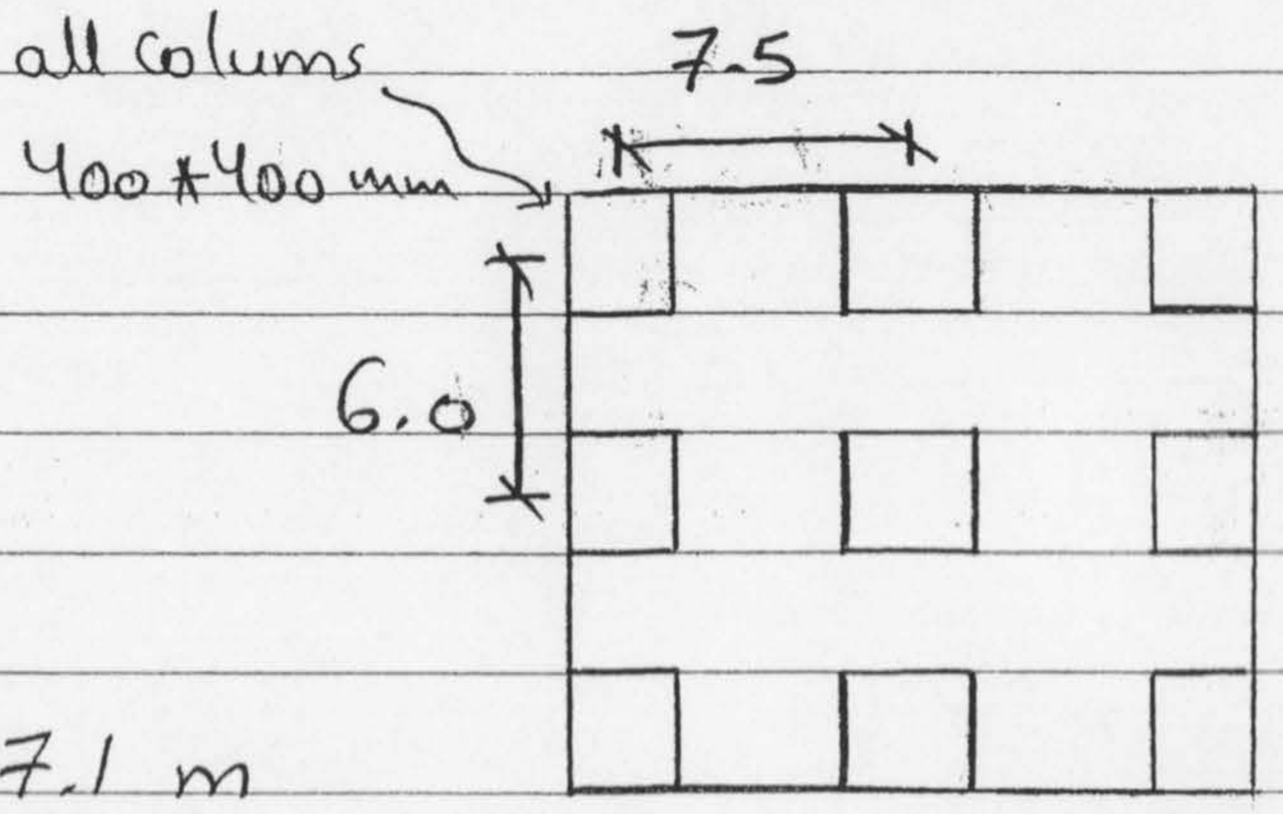
Panel = 4



interior panel = 8

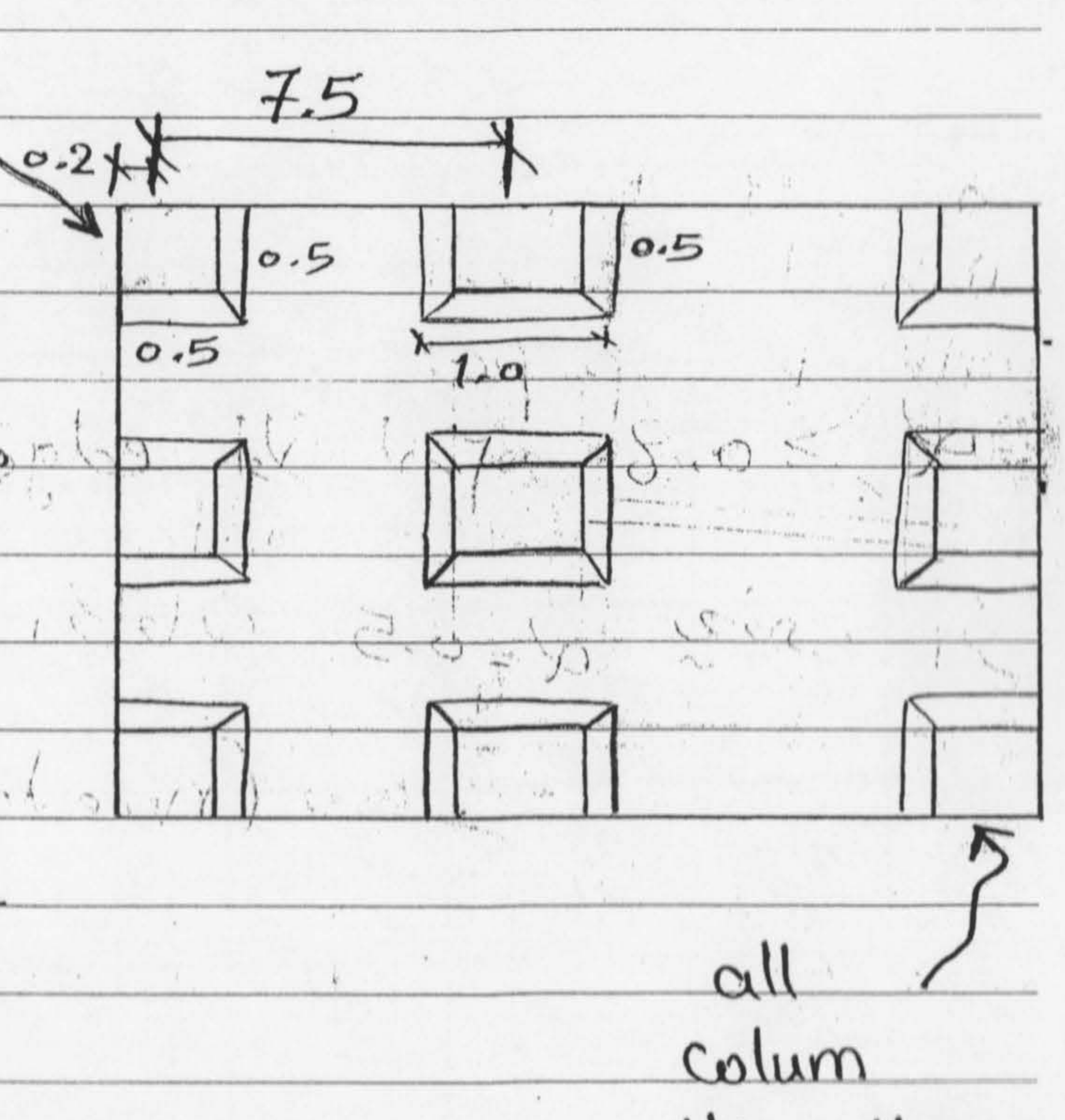
exterior panel = 1 (X)

L_n هو البعد الصافي



ناخذ البعد الاكبر ثم نطرح
منه نصف بعد الـ colum
من جهتين لنجد البعد الصافي

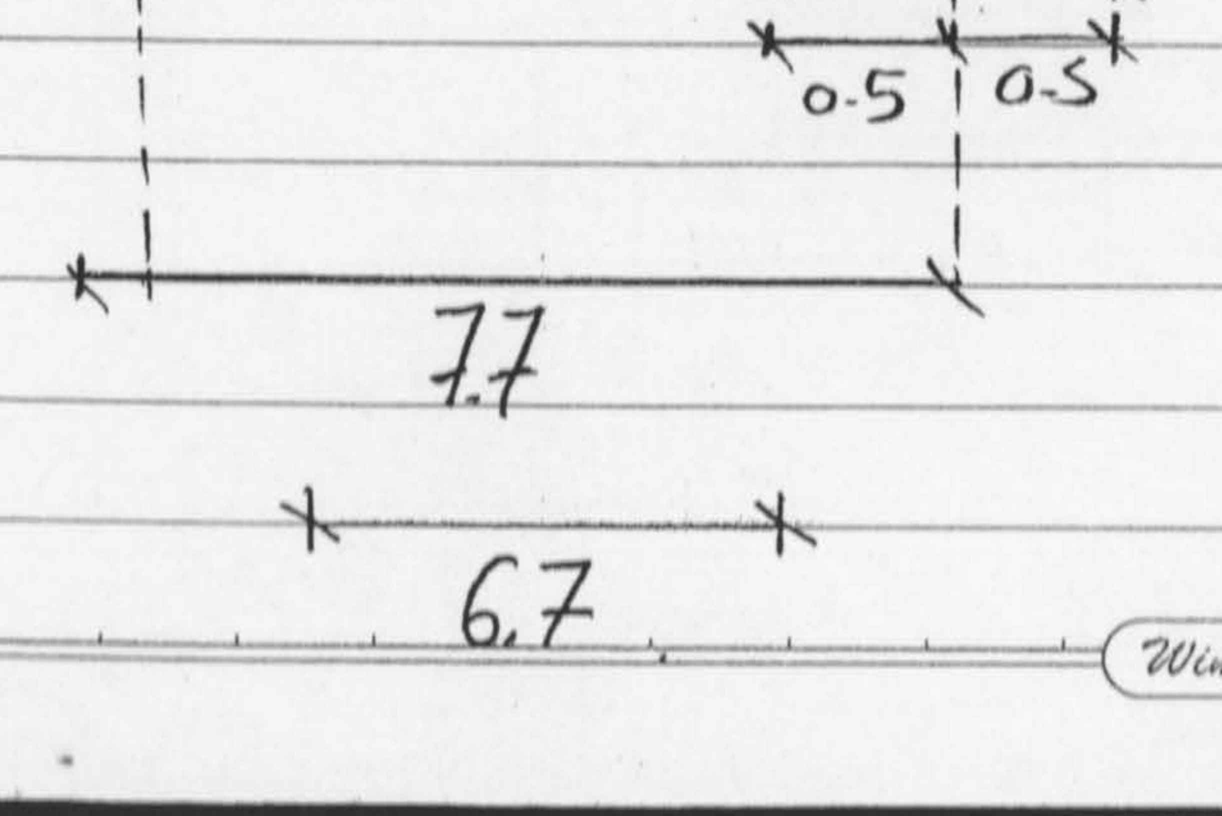
$$L_n = 7.5 - \frac{0.4}{2} - \frac{0.4}{2} = 7.1 \text{ m}$$

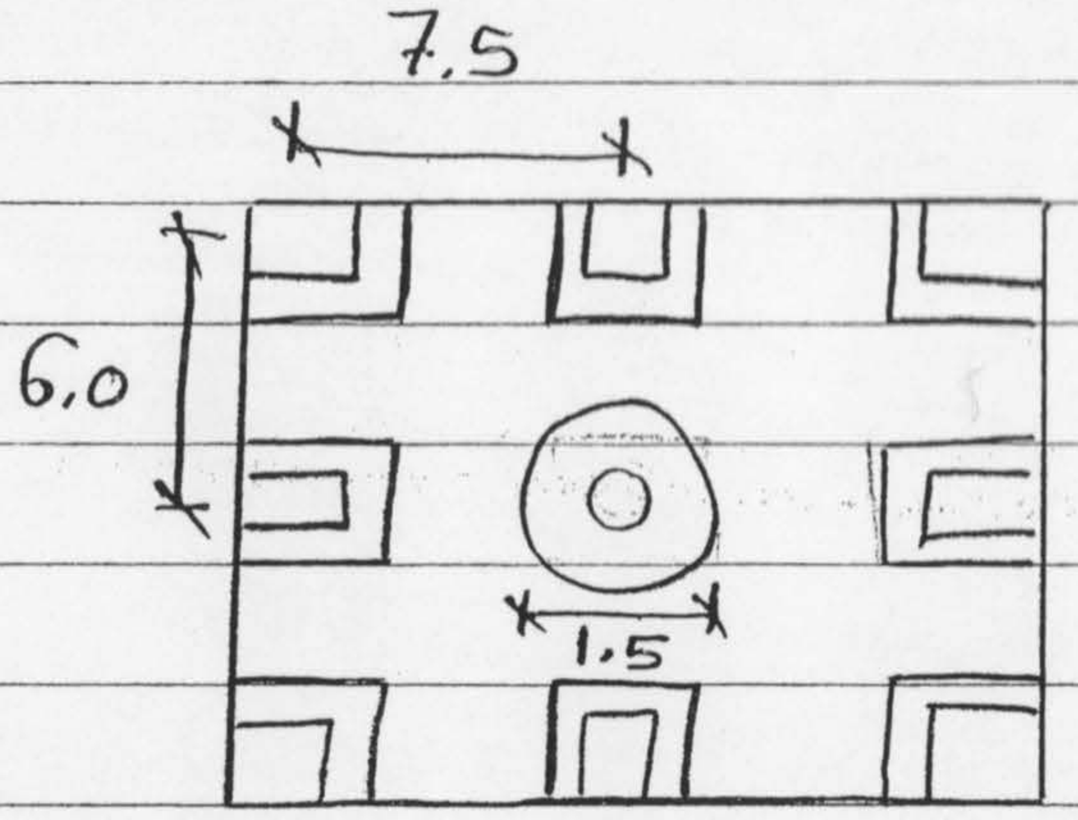


$$L_n = (7.5 + 0.2) - 0.5 - 0.5$$
$$L_n = 6.7$$

(½ 1.0)

(or) $L_n = 7.5 - 0.3 - 0.5 = 6.7$

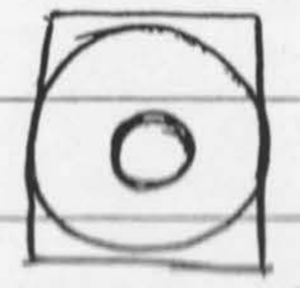




يأخذ البعد الاكبر لان أخطر ويطرح
منه انصاف الاعمدة

$Ln = 7.5 - 0.4 = 7.1$

أو يحول الدائرة الى مربع مكافئ



$Ln = 7.5 - \frac{0.4}{2} - \frac{0.89 * 1.5}{2}$

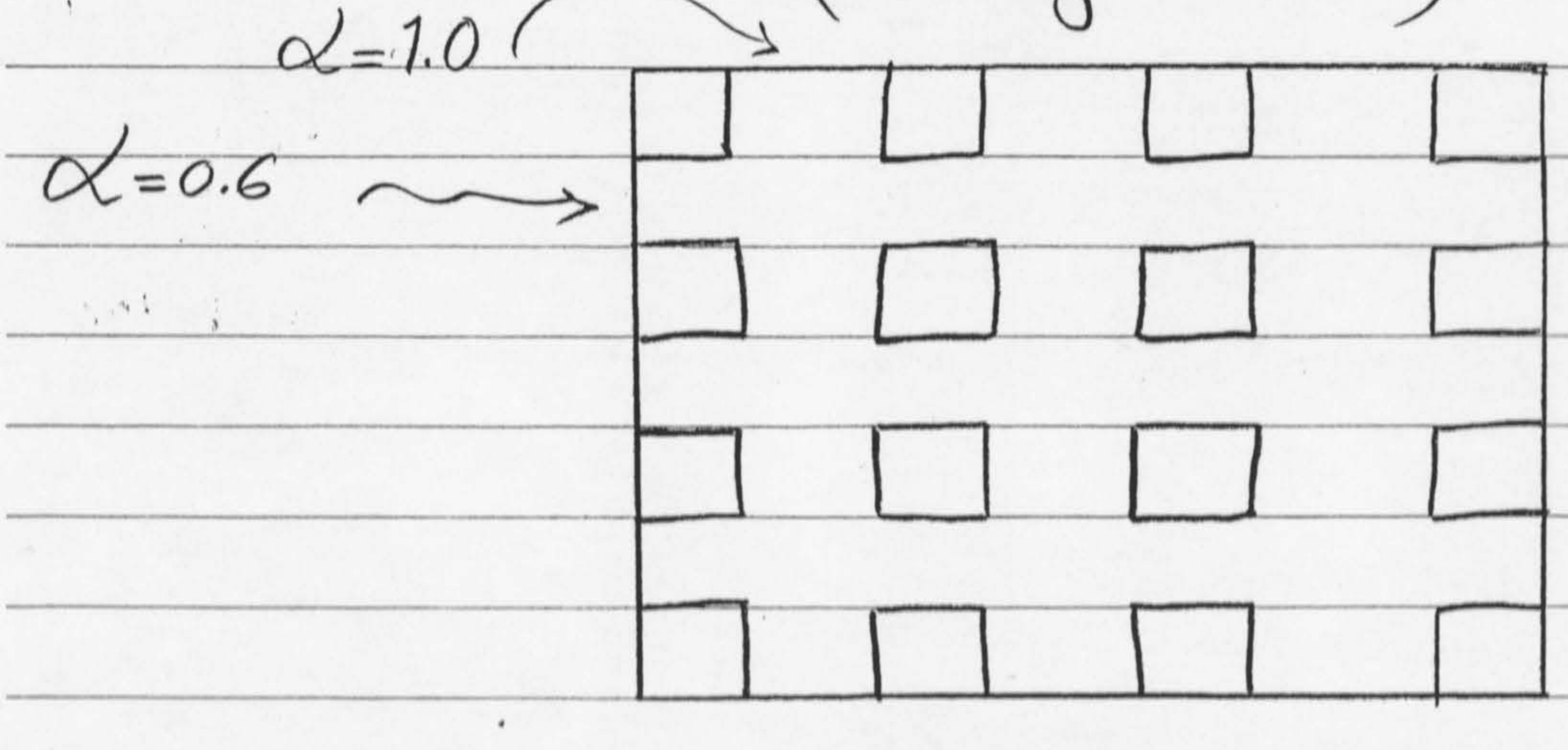
$Ln = 6.69$

0.89 d

* متى نعرف هو edge beam اولا لازم $\alpha \geq 0.8$

اذا كانت وحدة من الكانات $\alpha = 0.5$ يعني انو

هو (no edge beam)



15/10/2015

two - way slab

- slab beam System
- flat plate
- flat Slab
  - (flat plate and flat slab) with interior beam
    - with edge beam
    - without edge beam
- two-way joint (wafle slab)

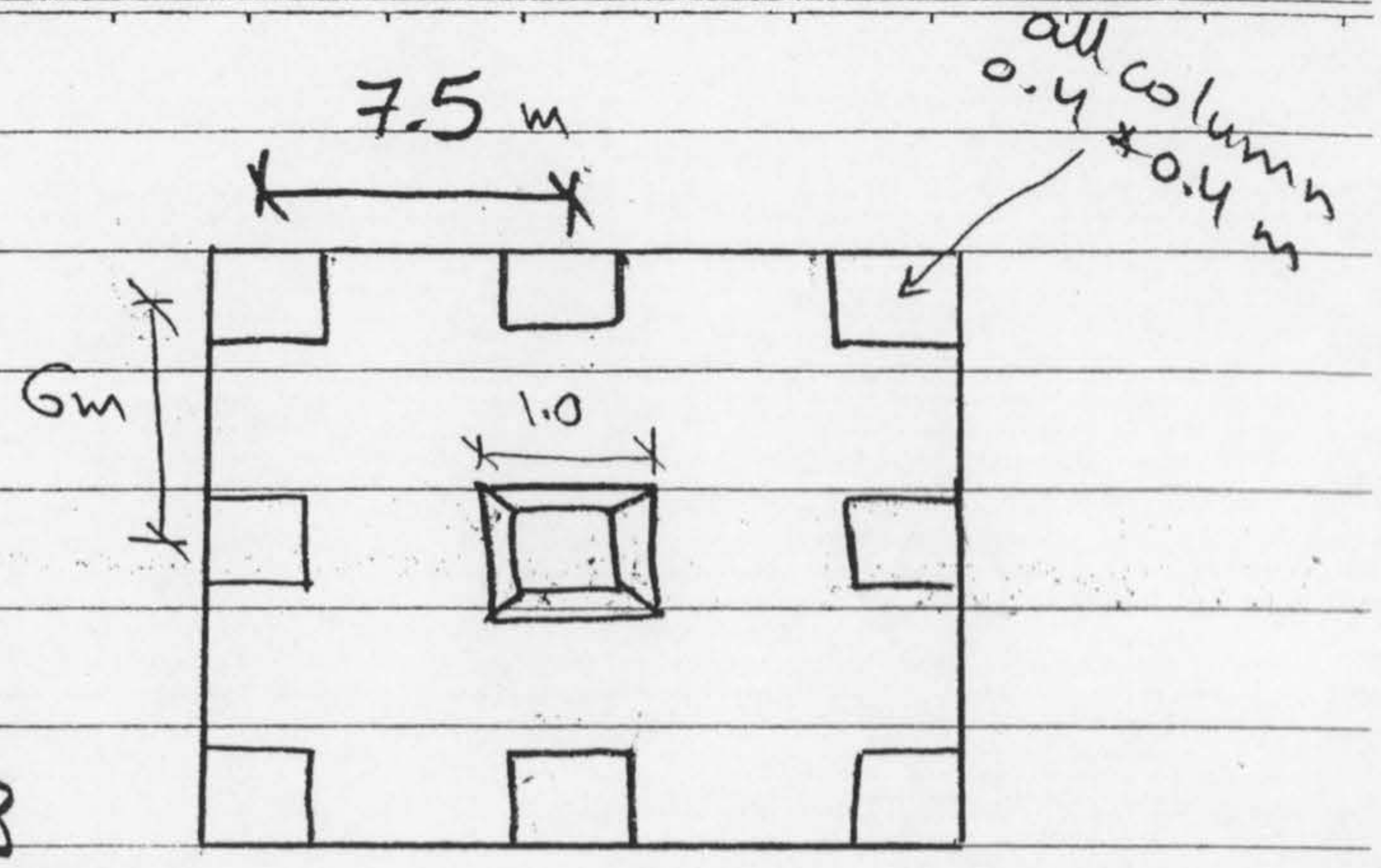
يتميز ال Panel الى كده

(١) with drop panel أو without drop panel -

(٢) داخلي أو خارجي .
interior   exterior

(٣) with edge beam أو without edge beam

لوجود capital في
المنتصف يكون هنا
2 Ln



$Ln_{(1)} = 7.5 - \frac{0.4}{2} - \frac{0.4}{2} = 7.1$

$Ln_{(2)} = 7.5 - \frac{0.4}{2} - \frac{1.0}{2} = 6.8$

Minimum thickness   أقل بعد   oneway

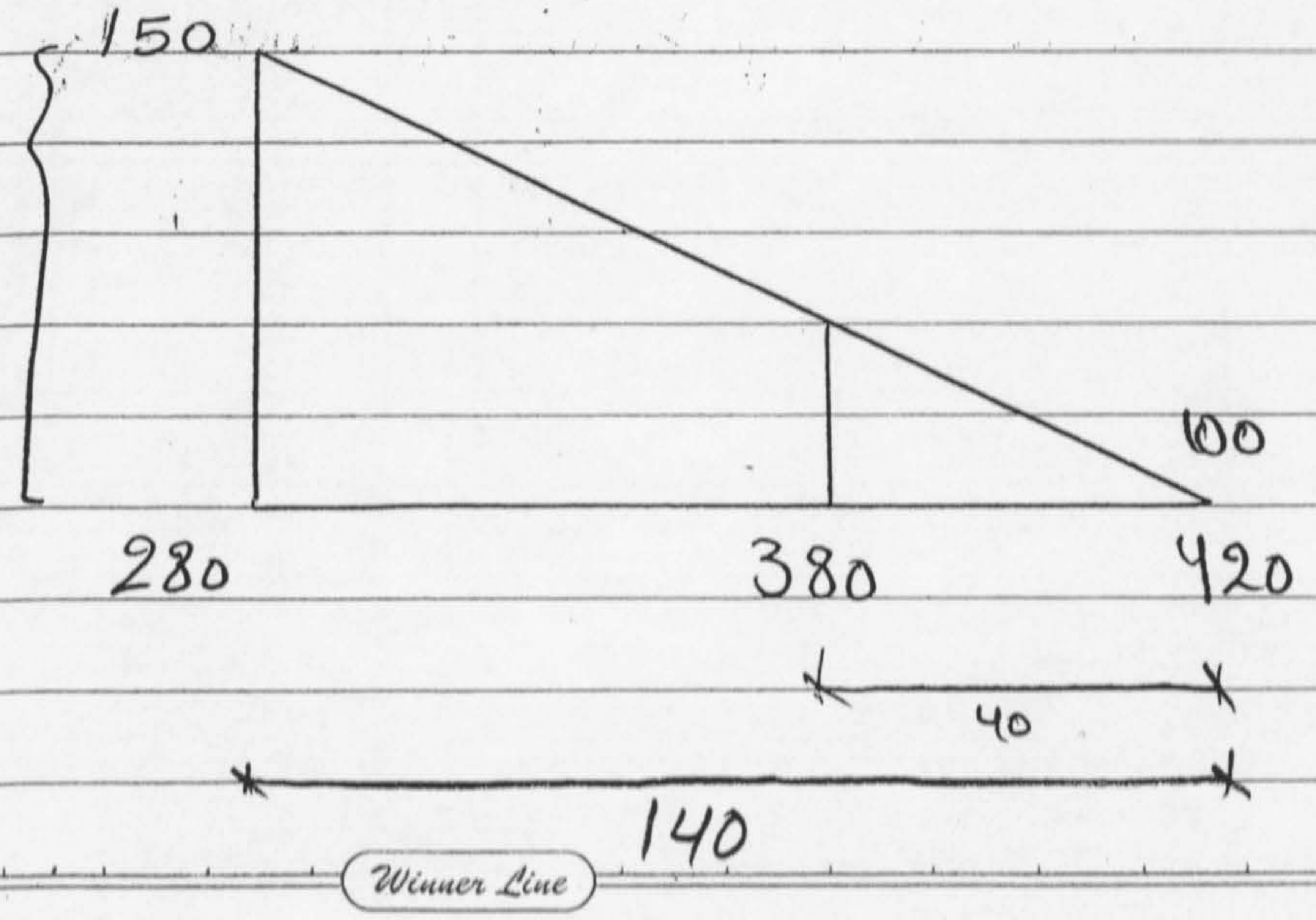
with drop panel   100
without drop panel   125.

مثال ع ال interpolation

(100 – 150)
الفرق بين

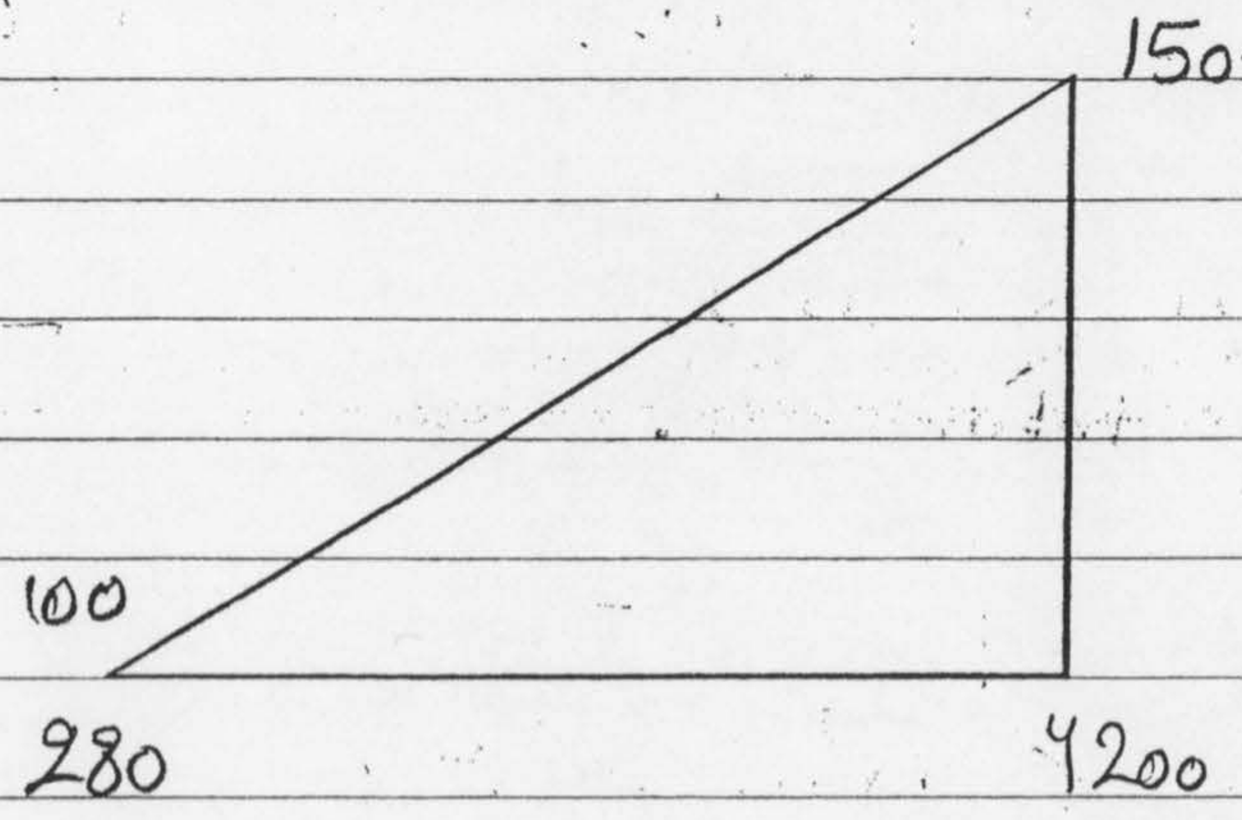
$\frac{40}{140} * 50$

$= 14 + 100$
$= 140$

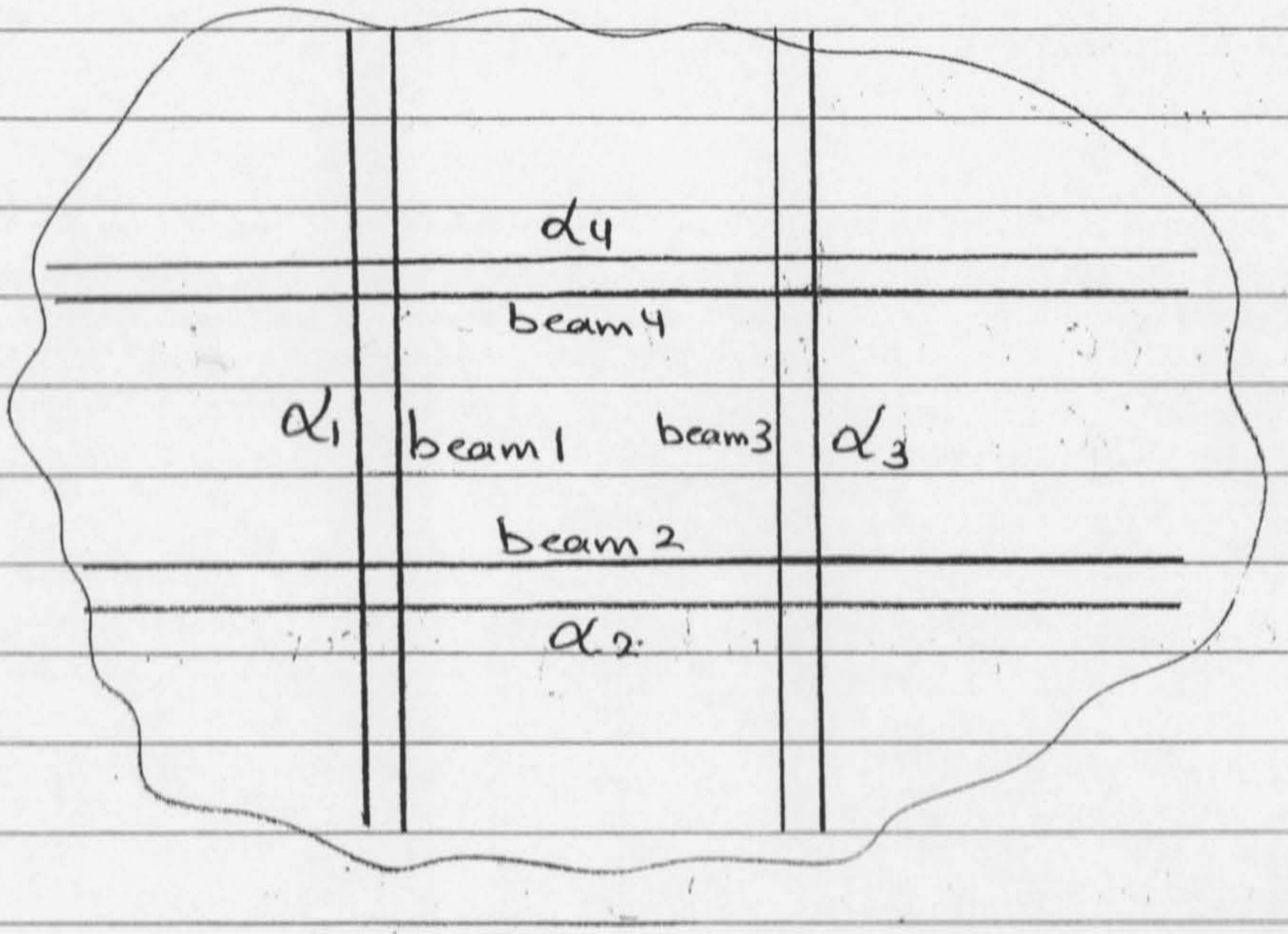


$50 * \frac{100}{140} = 35$

$100 + 35 = 135$



Slab beam System :



$$\alpha_m = \frac{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}{4}$$

① $\alpha_m \leq 0.2$ — يعتبر البيم ضعيف

go to table — ياخذ الـ thickness من الجدول

ملزمة ① ص١

② $0.2 < \alpha_m \leq 2.0$

الـ thickness من معادلة:

$$t = \frac{L_n\left(0.8 + \frac{f_y}{1400}\right)}{36 + 5\beta(\alpha_m - 0.2)} \geq 125 \quad \text{--- eq ①}$$

③ $\alpha_m > 2.0$

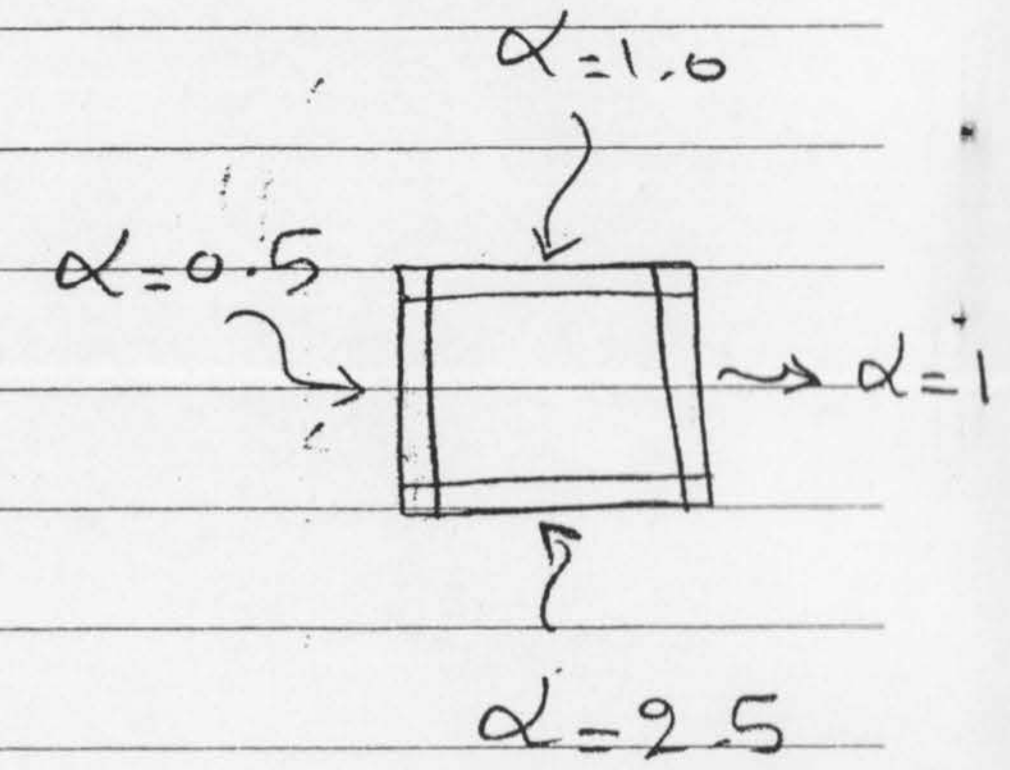
$$t = \frac{L_n\left(0.8 + \frac{f_y}{1400}\right)}{36 + 9\beta} \geq 90 \quad \text{--- eq ②}$$

L_n : Clear Span in Long direction

$$\beta = \frac{\text{Clear span in Long direction}}{\text{Clear span in Short direction}}$$ ← البعد الصافي

Exterior panel ☆

$\alpha_{edge} < 0.8$ (بالنسبة للحافة الخارجية فقط — اذا $(\alpha < 0.8)$ لازم نضرب ب 1.1)



$t = eq(1) * \underline{\underline{1.1}} \geq 125$

اذا الناتج طلع 130 نضربه * 1.1

$130 * 1.1 = 143$ ⟶ ناخذ هذا الرقم

$100 * 1.1 = 110$ ⟶ فما ناخذ هذا الرقم لان اقل من 125 فناخذ 125 بدلاً عنه.

لازم تكون الحافات خارجية واقل من $\alpha < 0.8$

$t = eq(2) * \underline{\underline{1.1}} \geq 90$

$\alpha_m = 5$ ناخذ الحالة (2) اي المعادلة الاولى eq(1)

اذا تختلف الابعاد ، كل مرة أطلع سمك (thickness) واحياناً نستفاد من التناظر (symmetric)

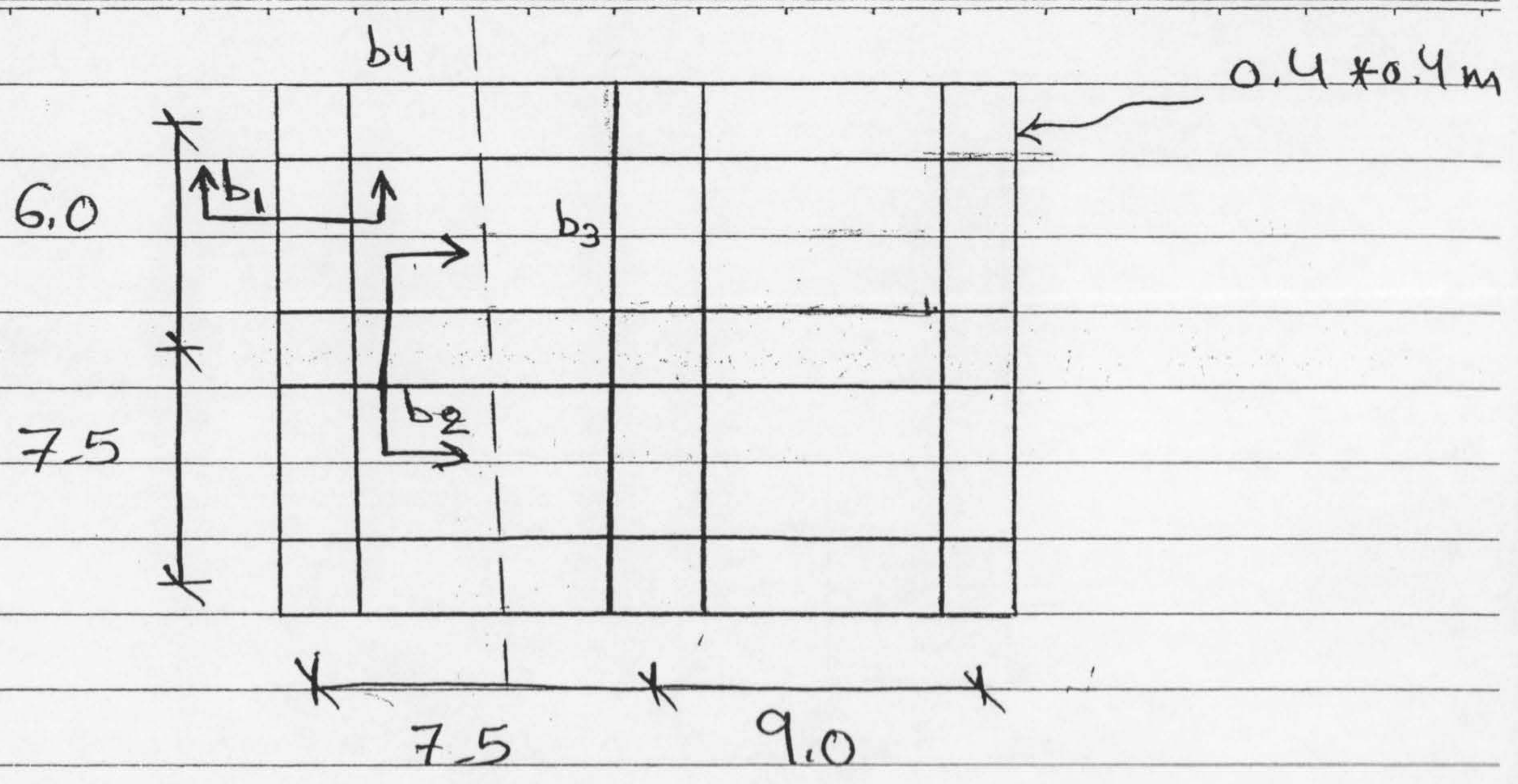
---

* اذا ماكو beam فتكون قيمة $\alpha = 0$.

$$\alpha = \frac{E_b * I_b}{E_s * I_s}$$

اذا كانت المادة نفسها $E_b = E_s$

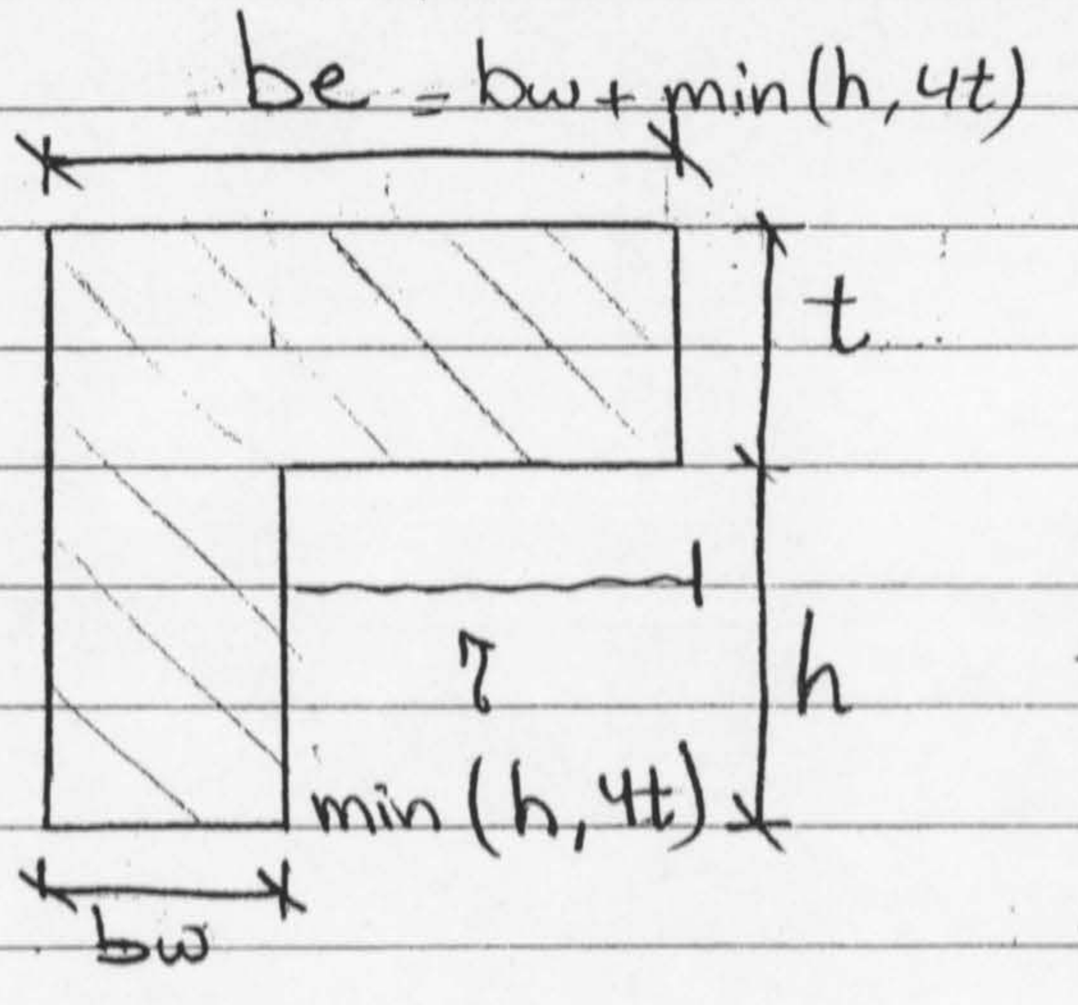
$$\alpha = \frac{I_b}{I_s}$$



<u>note</u> اذا أخذنا قطع بالبيمات الخارجية يكون شكل القطع (L) مقلوب ، واذا أخذنا بالبيمات الداخلية يكون شكل (T)

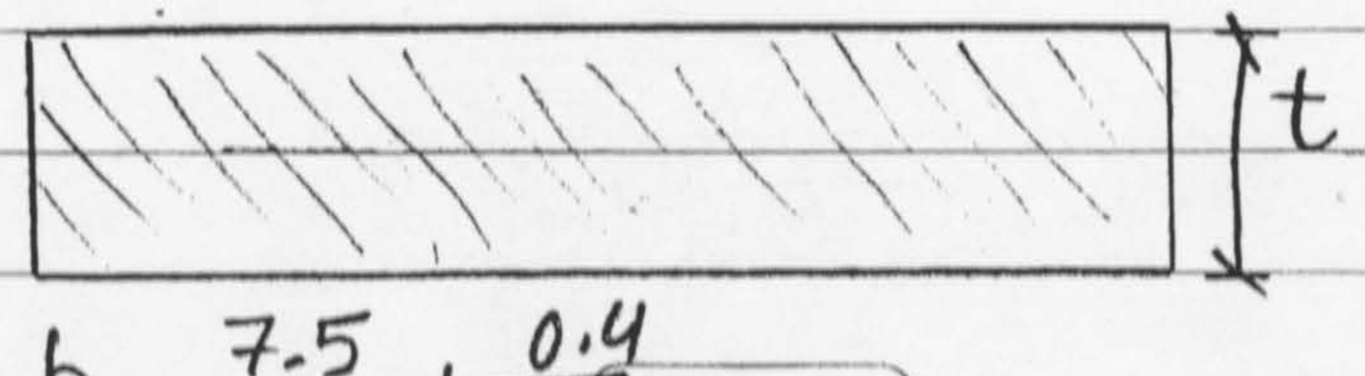
ال t هنا إما أن تعطى بالسؤال أو ال $\frac{\text{Parameter}}{2}$

beams



قطع ال {b4 , b1}

slab



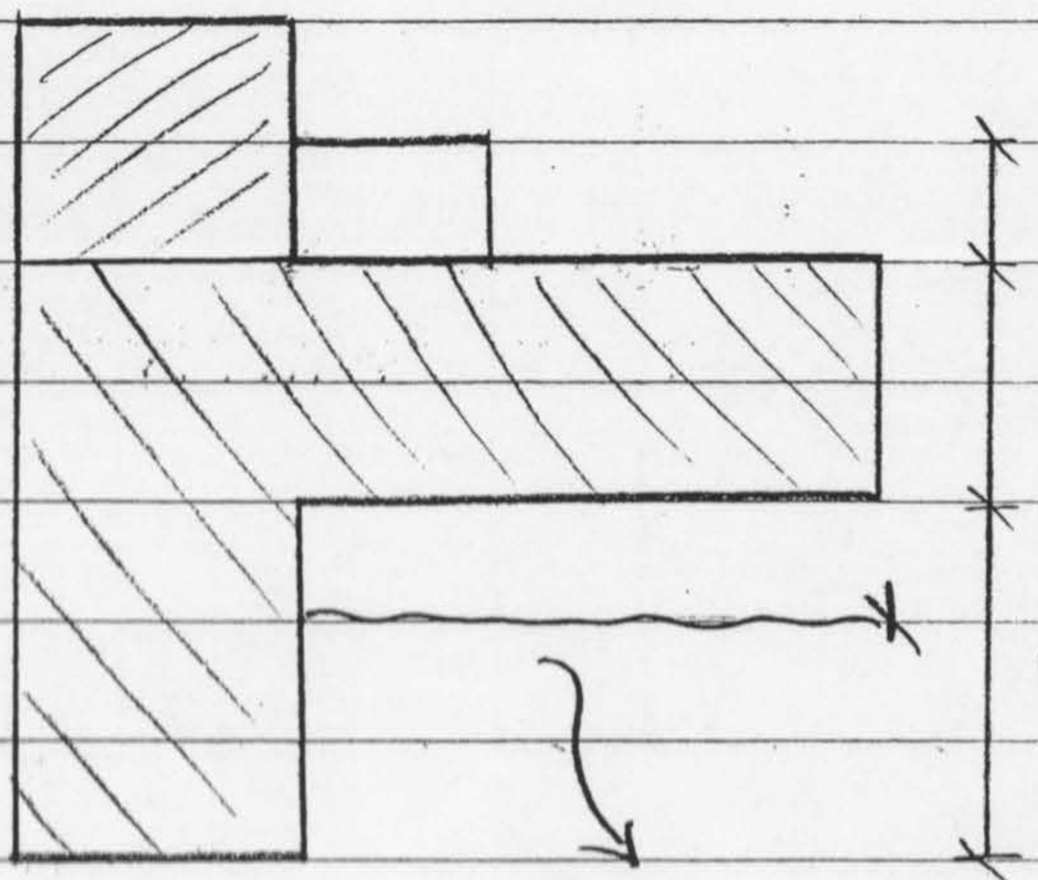
$$I_s = \frac{bh^3}{12}$$

$$b = \frac{7.5}{2} + \frac{0.4}{2}$$

نصف نور المكان بروح لا اط　　باقي نور العمود

Winner Line

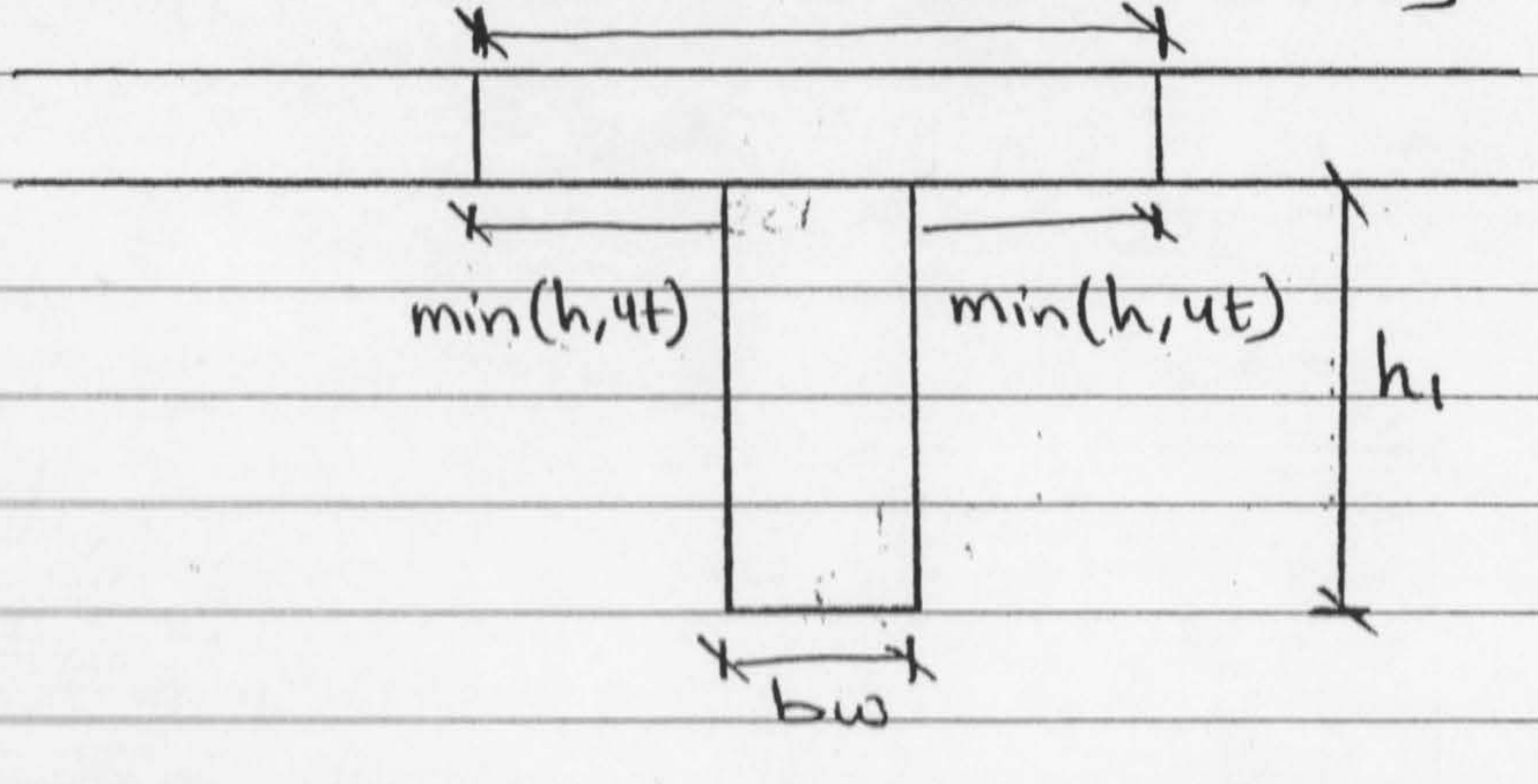
لو كان هناك صبة فوق ال Slab



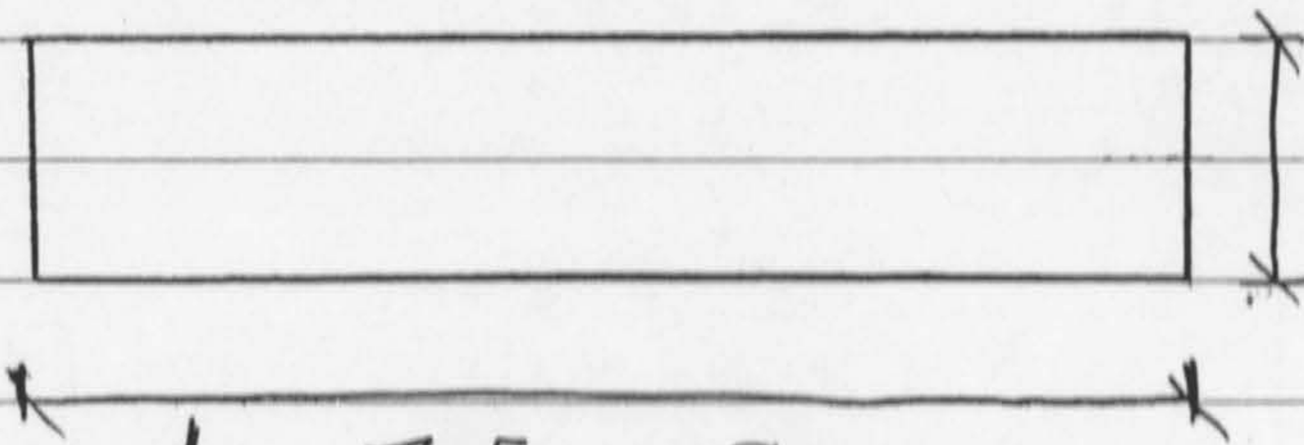
$$\min\left[\max(h_1, h_2),\ 4t\right]$$

beam

$$b_E = b_w + 2\left[\min(h, 4t)\right]$$ {b_2, b_3} تطرح

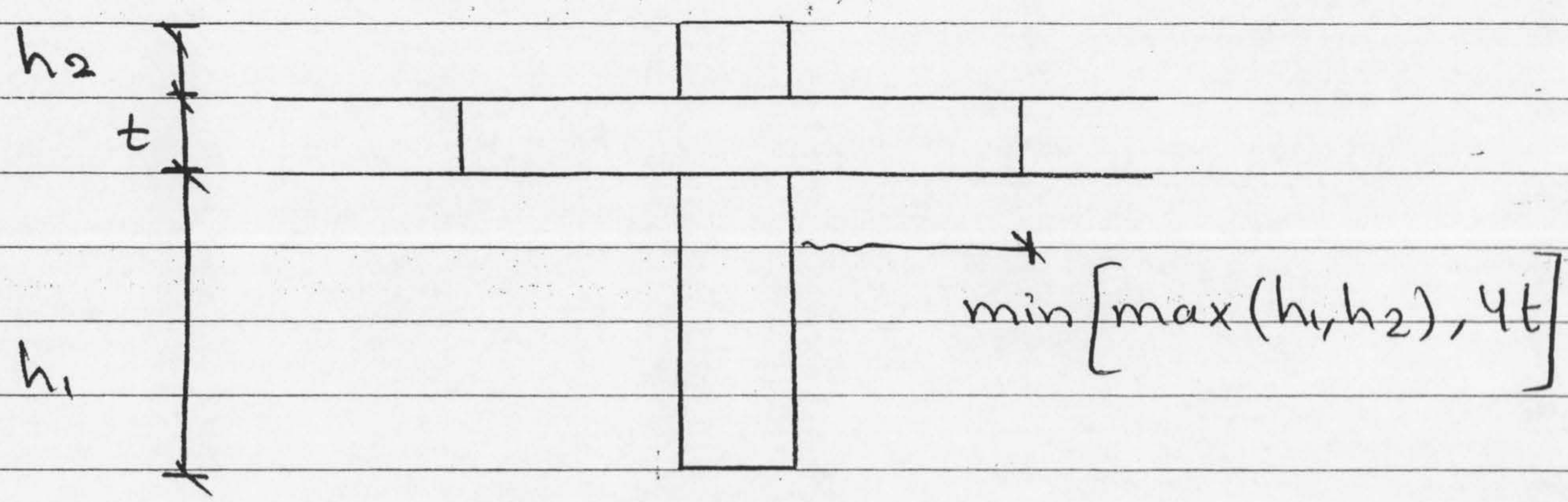


Slab

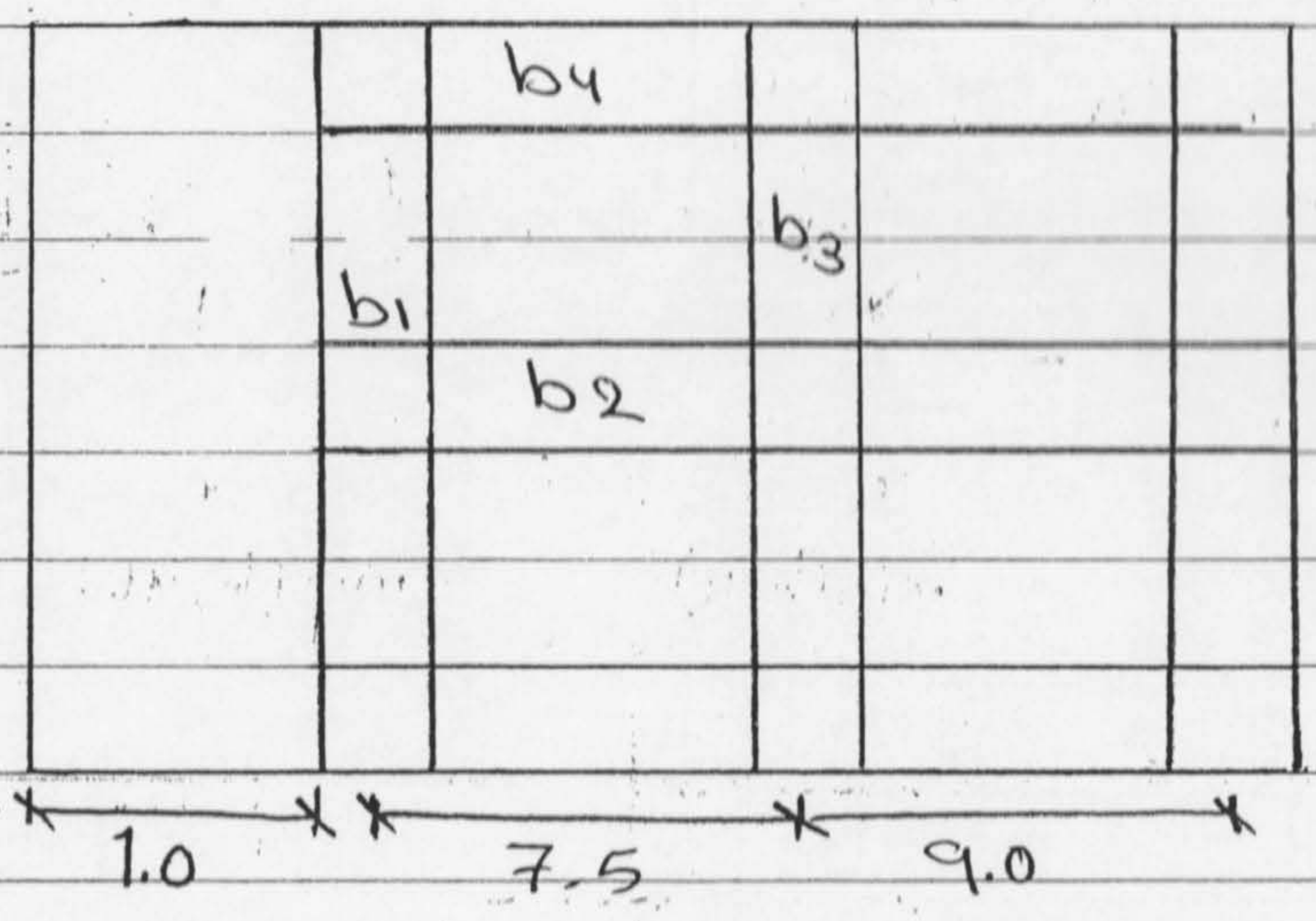


$$I_s = \frac{bt^3}{12}$$

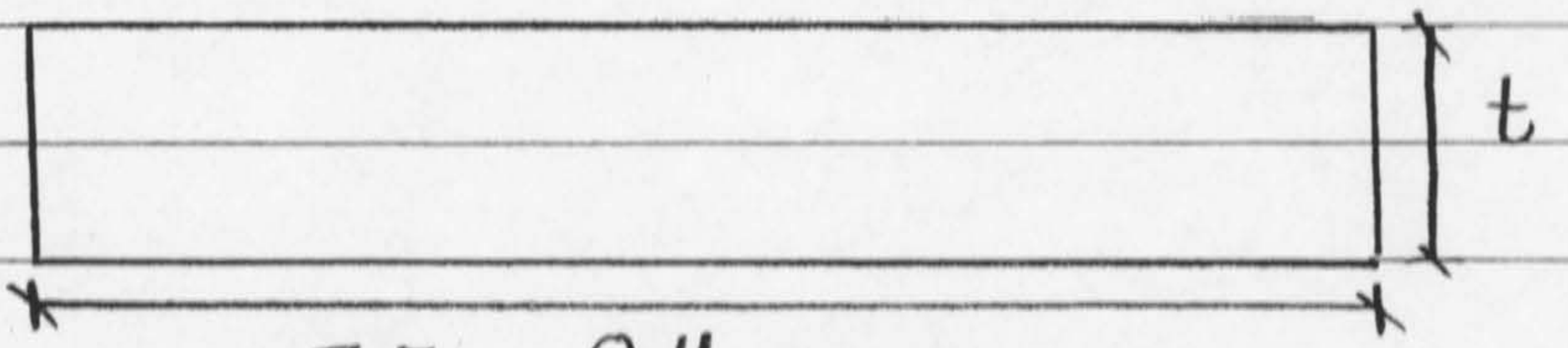
$$b = \frac{7.5}{2} + \frac{9.0}{2}$$



لو اكو ضربة رح تؤثر على ال b_1 عند حساب ال I_s



* اذا البيم خارجي T_Section
* واذا البيم داخلي L مقلوب



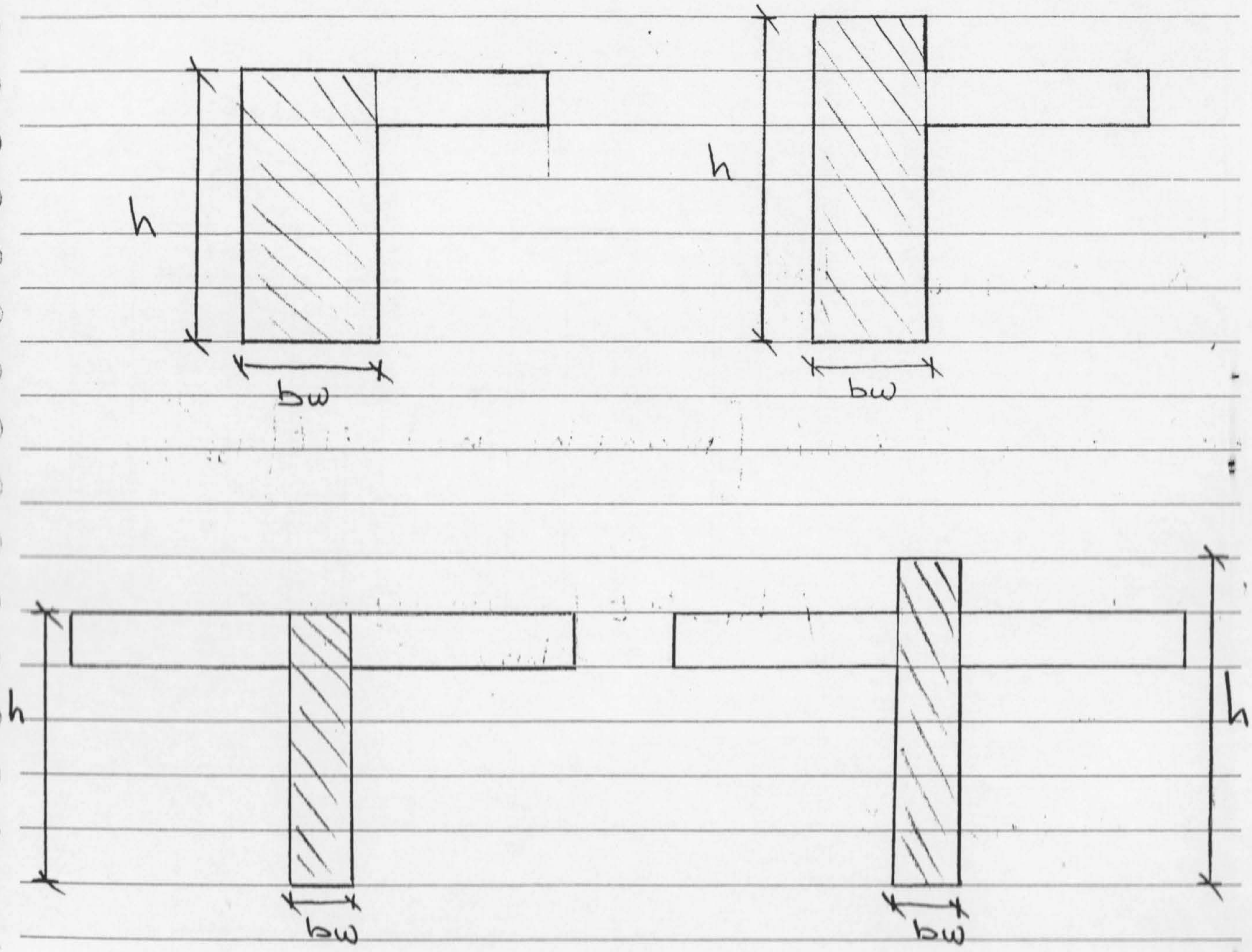
في حالة عندي صبه طول ال slab = مجموع العتبر البارزة عرض الصبة.

$$L = \frac{7.5}{2} + \frac{0.4}{2} + 1.0$$

الموضوع :   التاريخ / / ٢٠٠

$I_s = \frac{t^3 . L}{12}$ $\qquad$ $I_b = ??$

في حالة وجود مثل هذه الاشكال حتى نجد Ib لازم نروح نطلع
ال centroid ونعين I الـ MOI
ثم نطلع الـ I للشكل المظلل فقط



$I_b = \frac{b_w h^3}{12} * K$ $\qquad$ قانون آخر

Winner Line

الـ K له شرطان ان لم تتحقق نرجع لل Centroid
الموجود صف أول ده

$$K \rightarrow \begin{cases} 2 < \dfrac{b_E}{b_w} < 4 \\[2ex] 0.2 < \dfrac{t}{h} < 0.5 \end{cases}$$

اذا تحقق الشرطان نطبق قانون الـ K

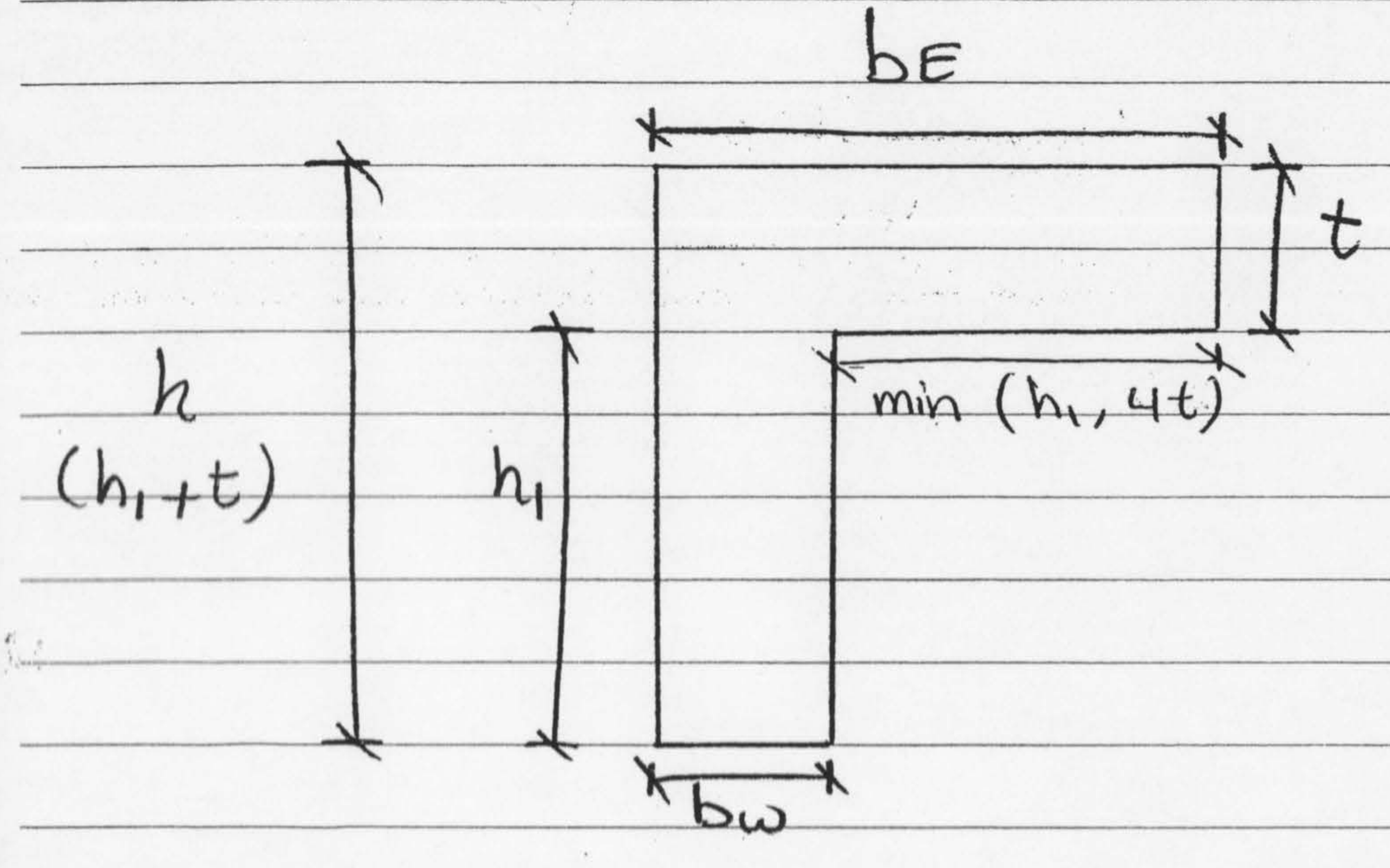
$$\boxed{K = 1.0 + 0.2\,\frac{b_E}{b_w}}$$

$$b_E = b_w + 2 * \min\left[\max(h_1, h_2)\,,\ 4t\right]$$ لو يكون أكو شي فوق الـ slab

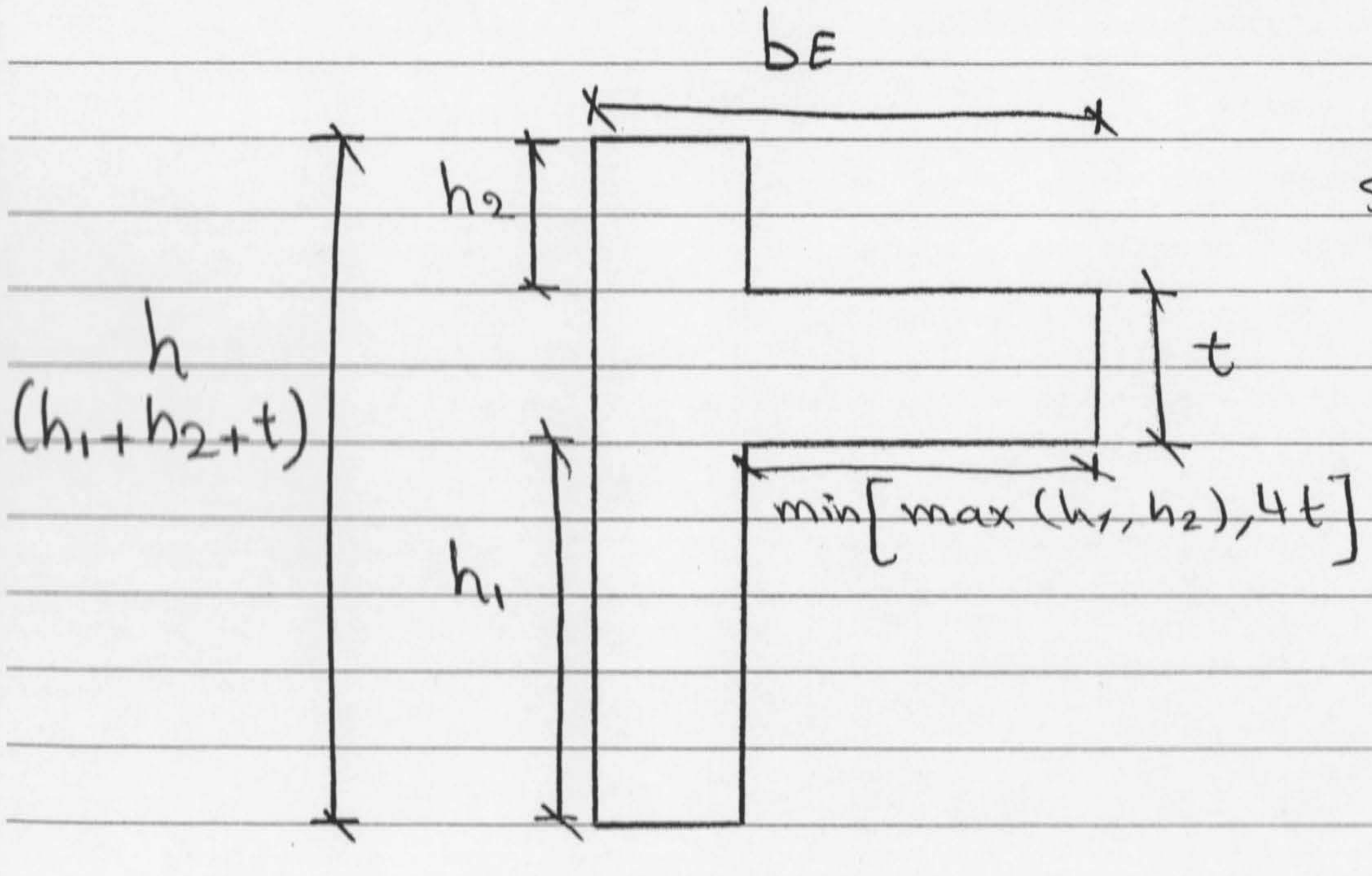
$$b_E = b_w + 2 * \min\left[h_1\,,\ 4t\right]$$ لو يكون ماكو شي فوق الـ slab

$$h = h_1 + h_2 + t$$

ماكو اي شي
فوك الـ slab



عندي صبة
فوك الـ slab



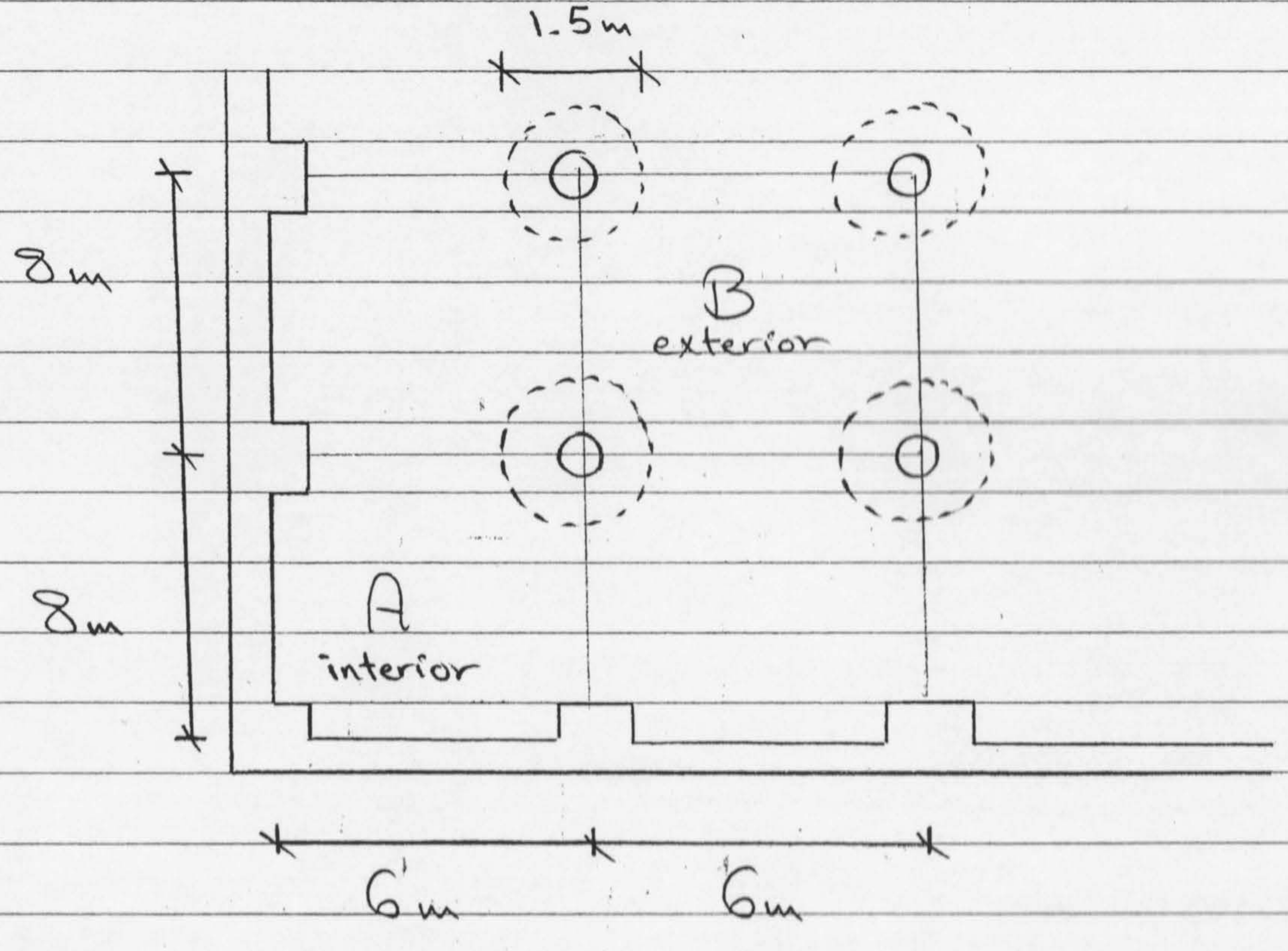
20/10/2015

note لازم يكون عندنا t أولي تكون قيمته

محيط ال Panel

180

Ex (1) P.22 بالملزمة



* flat plate
* all colum 0.6 * 0.6
* Fy = 420

ⓐ without d.p :-

a.1 – without edge beam

هنا نطلع البعد الصافي ناخد اكبر بعد

a.1.1.1 exterior $L_n = \underline{8} - 0.6 = 7.4\ m$

$\left(\frac{0.6}{2} + \frac{0.6}{2}\right)$

a.1.1.2 interior $L_n = \underline{\underline{8}} - 0.89 * 1.5 = 6.665\ m$

قانون ال thickness من الجدول

$t = \frac{L_n}{30} = \frac{7400\ (mm)}{30} = 247$ (exterior)

$t = \frac{L_n}{33} = \frac{6665}{33} = 202 > 125$ (interior)

∴ use $t = 250$ (mm) لتقريب لأقرب ربع

a.2 – with edge beam

exterior ⟹ $t = \frac{7400}{33} = 224 > 125$

interior ⟹ $t = \frac{6665}{33} = 202 > 125$

(b) with d.p

b.1 _ without edge beam

exterior $L_n = 8 - 0.6 = 7.4$ m
interior $L_n = 8 - 0.89 * 1.5 = 6.665$ m

ext. $t = \frac{7400}{33} = 224 > 100$

int. $t = \frac{6665}{36} = 185.1 > 100$

$t = 230$ mm نقارن الرقمين دول ناخد الاكبر ونقرب لأقرب عشرة

b.2 _ with edge beam

ext. $t = \frac{7400}{36} = 206 > 100$

int. $t = \frac{6665}{36} = 185.1 > 100$

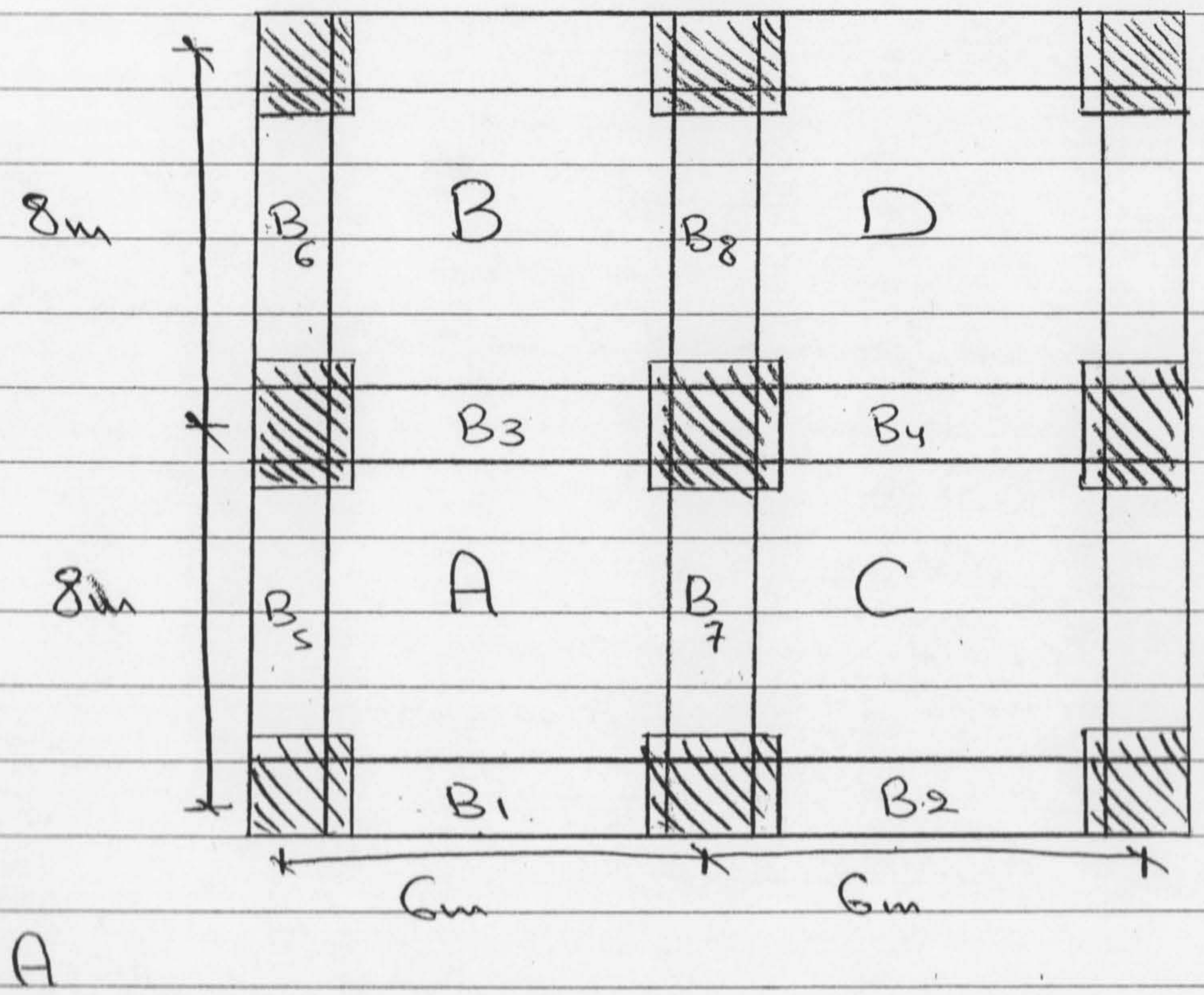
$\therefore t = 206 \simeq 210$ mm

Ex (2) t = 180 mm

edge Beam { B_1, B_2 (300 * 600) mm
B_5, B_6 (300 * 700) mm

All interior beam (300 * 600) mm B_7, B_8, B_4, B_3

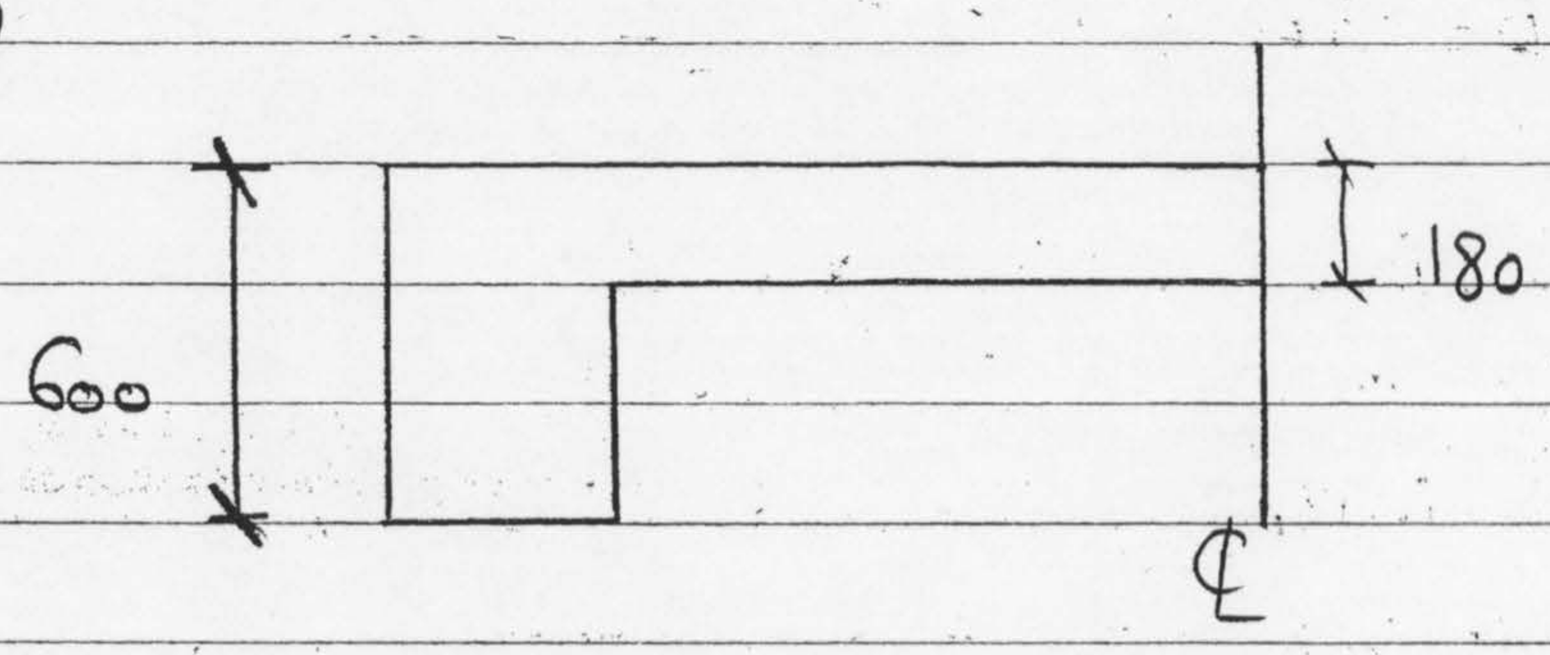
all colum (600 * 600) mm



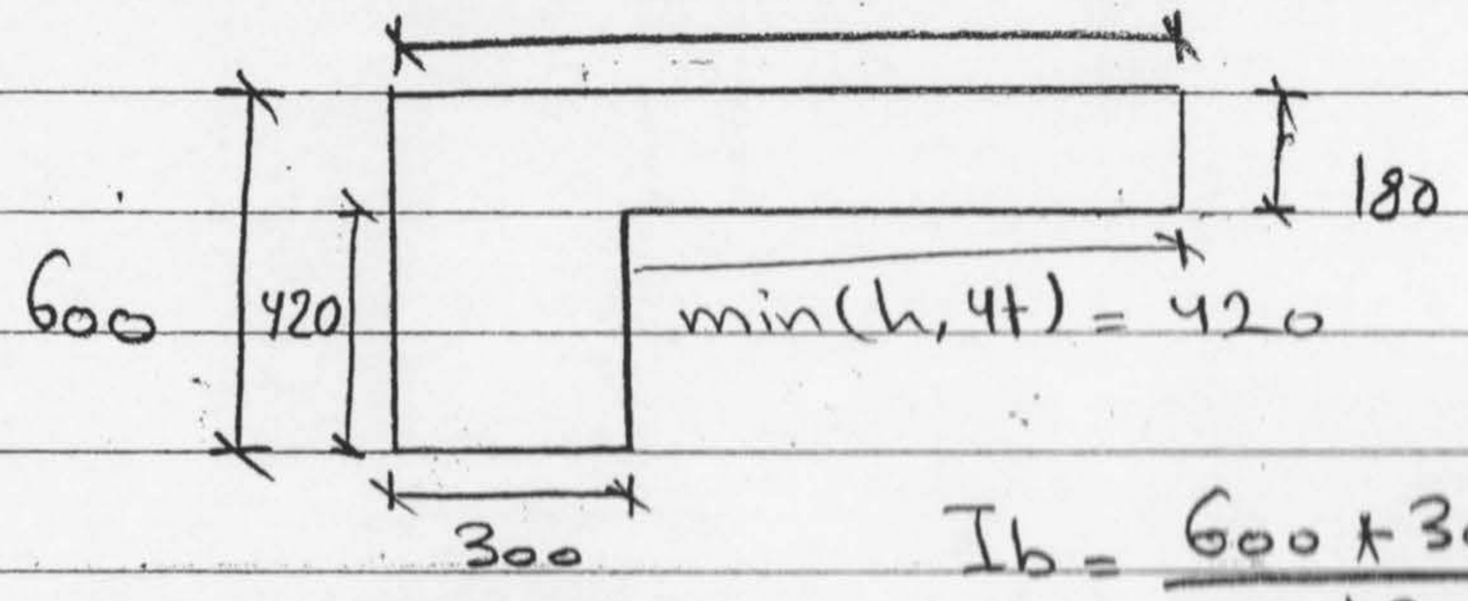
Panel A

$$\alpha_m = \frac{\alpha_{B_1} + \alpha_{B7} + \alpha_{B5} + \alpha_{B3}}{4}$$

beam① (B1)



$b_E = 300 + 420 = 720$



$$I_b = \frac{600 * 300^3}{12} * K$$

نشوف شروط ال K اذا تحققت نستغرقة

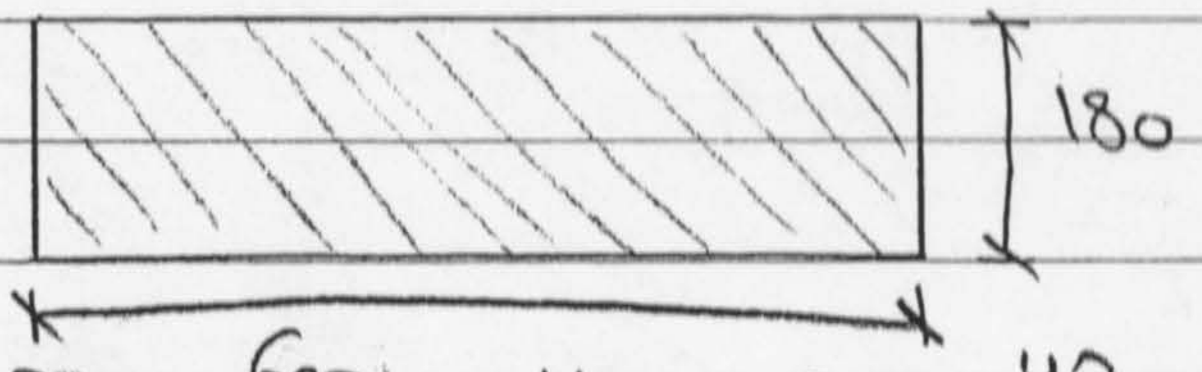
$$2 < \frac{720}{300} = 2.4 < 4$$

$$0.2 < \frac{180}{600} = 0.3 < 0.5$$

$$K = 1 + 0.2 * \frac{b_E}{b_w}$$

$$= 1 + 0.2 * \frac{720}{300} = 1.48$$

$$\therefore I_b = \frac{600 * 300^3}{12} * 1.48 = 7.99 * 10^9 \text{ mm}^4$$



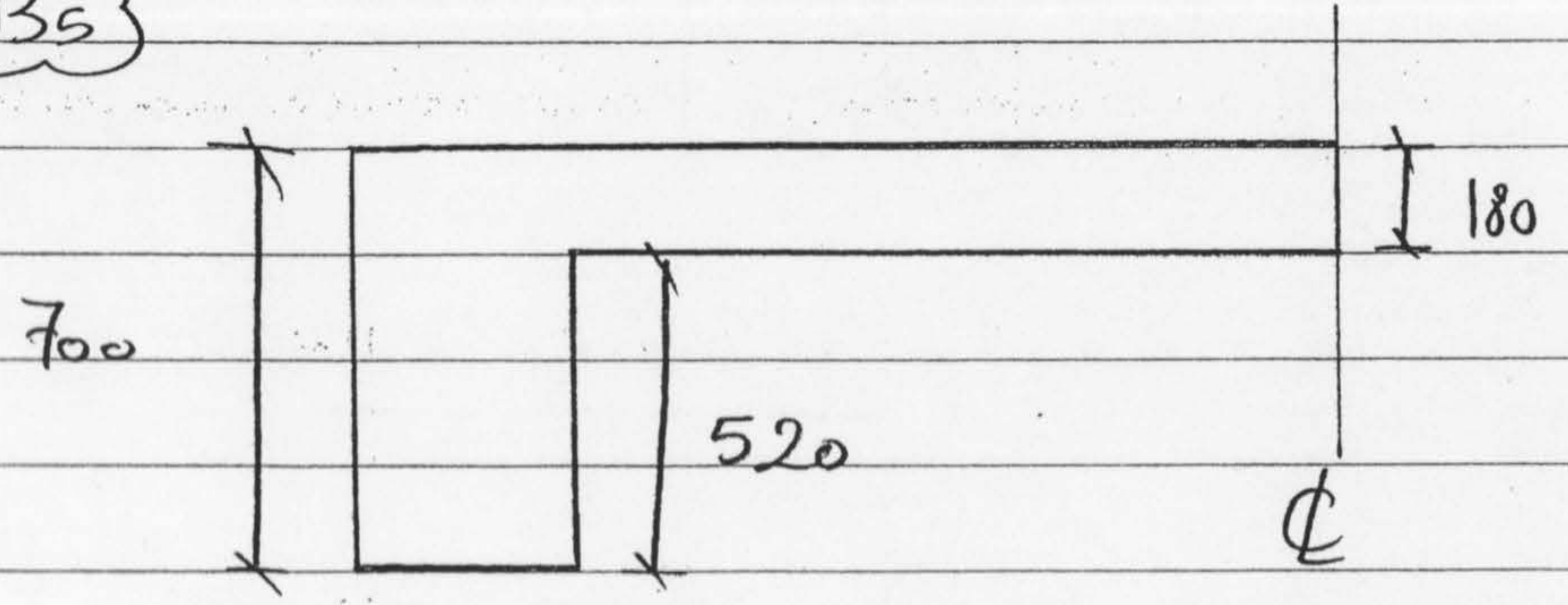
$$\frac{8000}{2} + \frac{600}{2} = 4000 + 300 = 4300$$

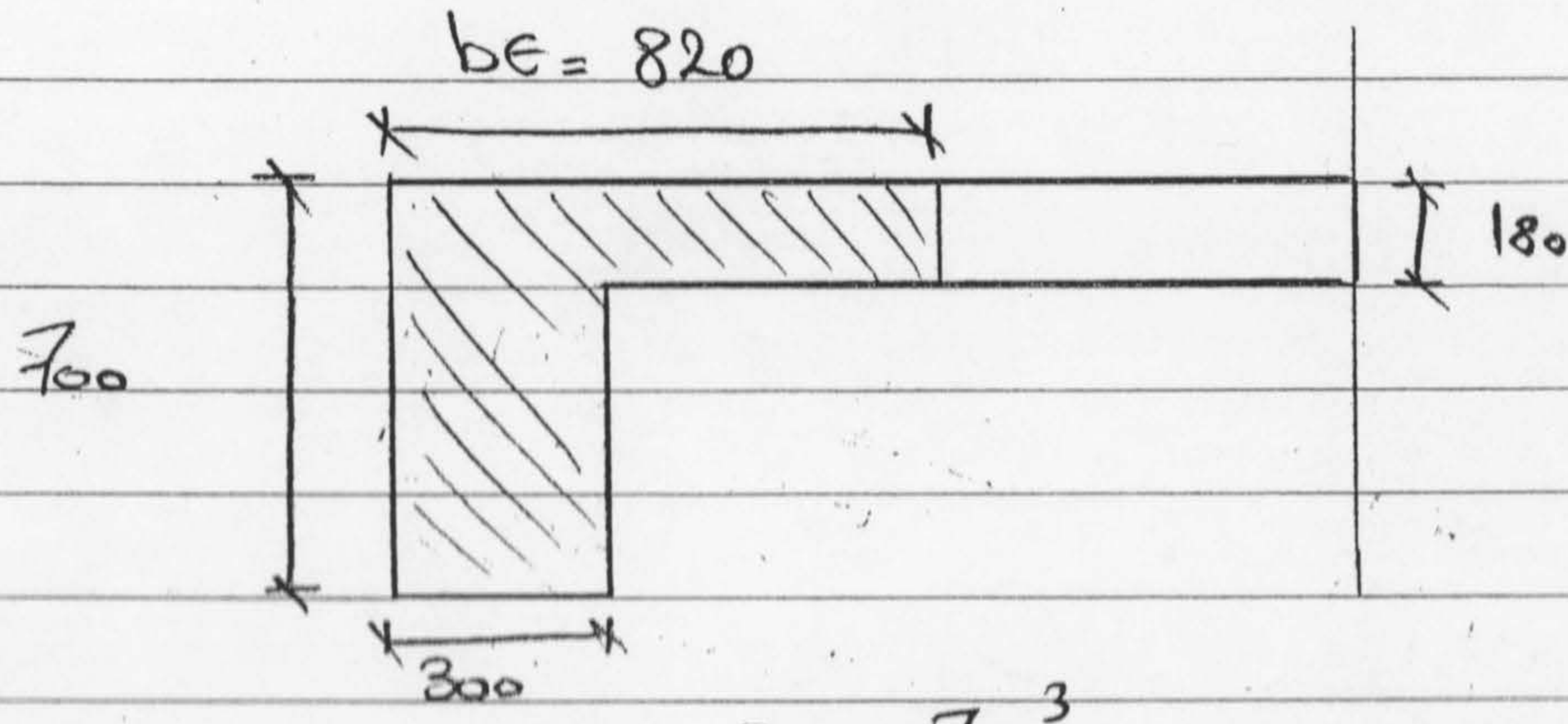
$$I_s = \frac{4300 * 180^3}{12} = 2.09 * 10^9 \text{ mm}^4$$

$$\alpha B_1 = \frac{I_{b1}}{I_{s1}} = \frac{7.992 * 10^9}{2.09 * 10^9} = 3.823 \quad = \alpha B_2$$

mm⁴ — due to Symmetry

beam 5 (B5)



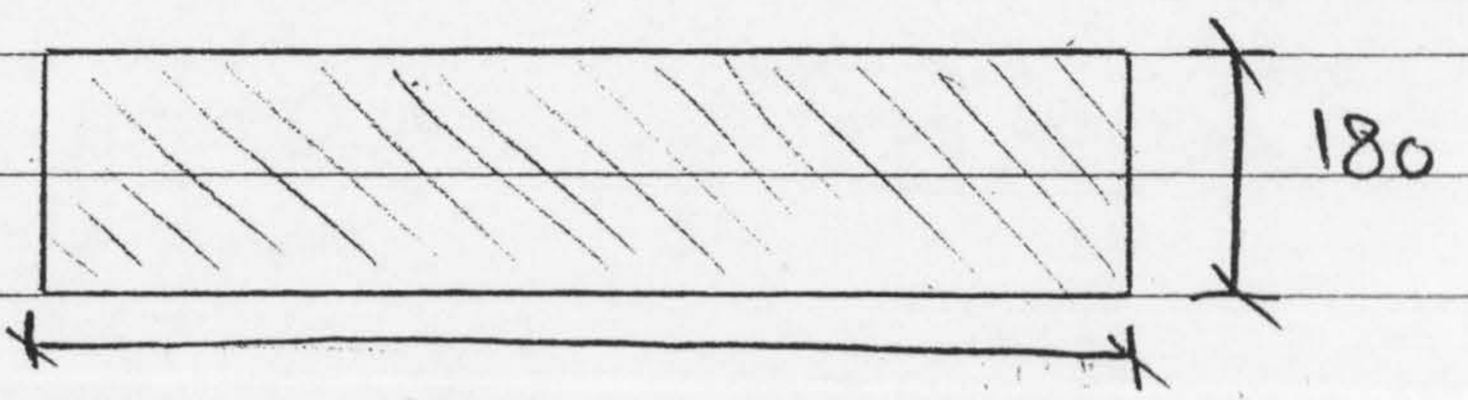


$$I_b = \frac{300 * 700^3}{12} * K$$

$$K = 1 + 0.2 * \frac{bE}{bw} = 1.546$$

$$2 < \frac{820}{300} = 2.73 < 4 \qquad 0.2 < \frac{180}{300} = 0.26 < 0.5$$

$$I_b = \frac{300 * 700^3}{12} * 1.546 = 13.26 * 10^9 \quad mm^4$$



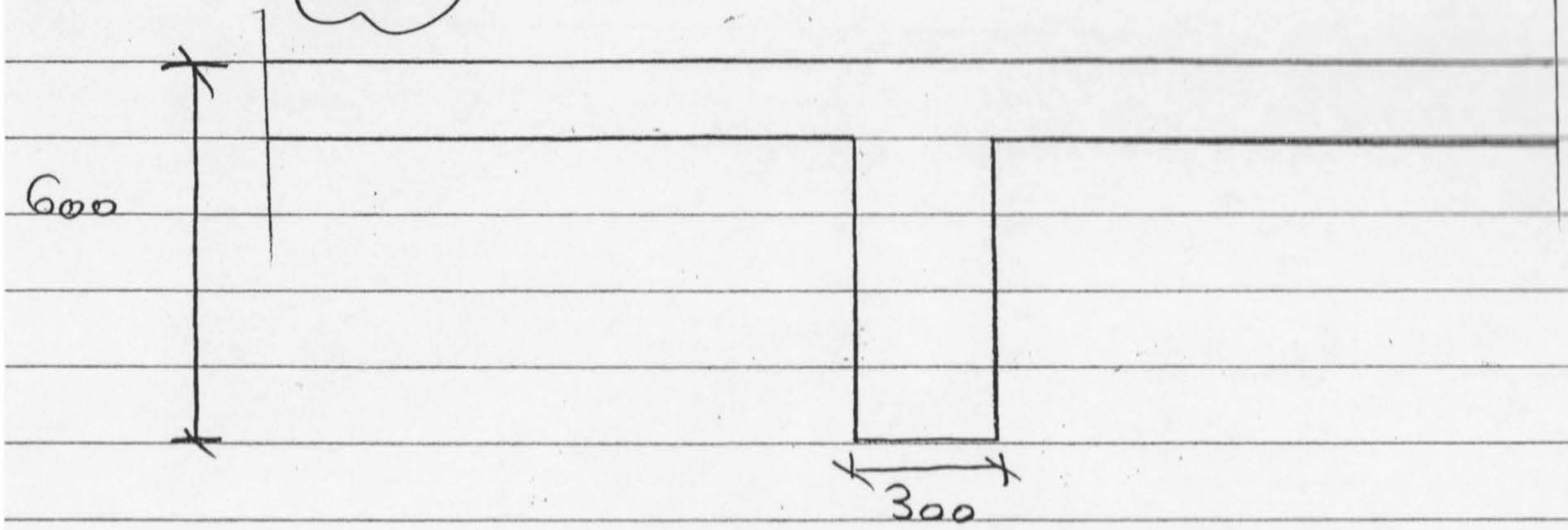
$$\frac{6000}{2} + \frac{600}{2} = 3000 + 300 = 3300$$

$$I_s = \frac{3300 * 180^3}{12} = 1.604 * 10^9 \ mm^4$$

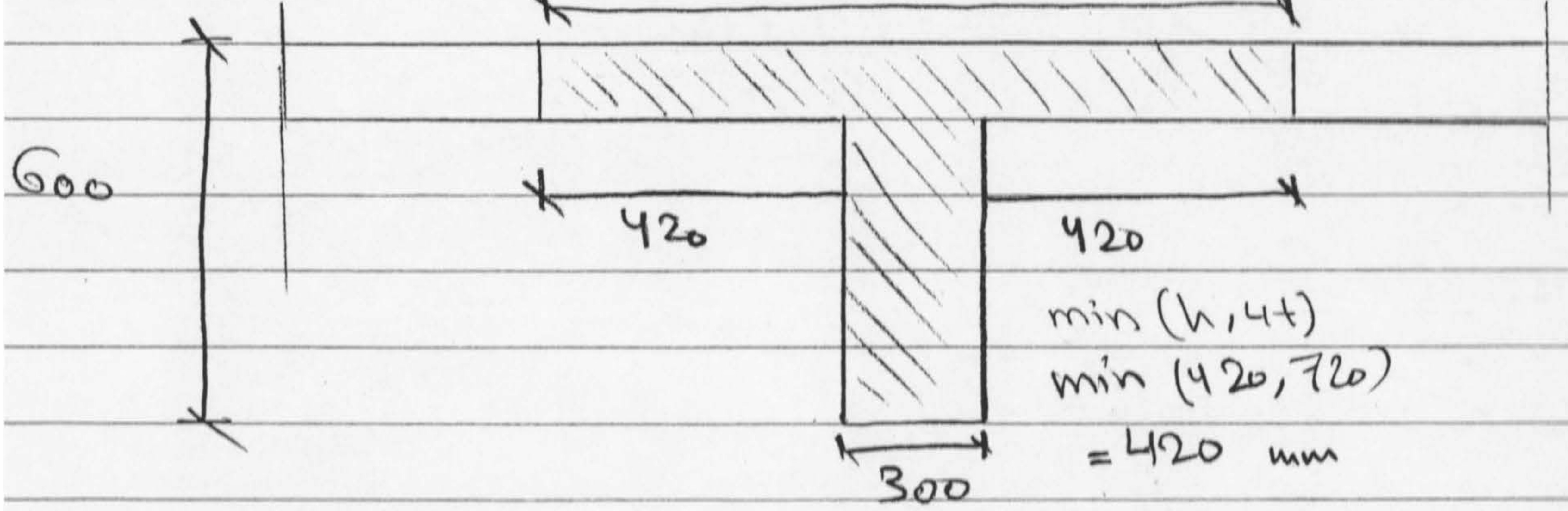
$$\alpha B_5 = \frac{I_{b5}}{I_{s5}} = \frac{13.26 * 10^9}{1.604 * 10^9} = 8.267 = \alpha B_6$$

due to Symmetry

beam 7 (B7)



$bE = 420 * 2 + 300 = 1140$



min (h, 4t)

min (420, 720)

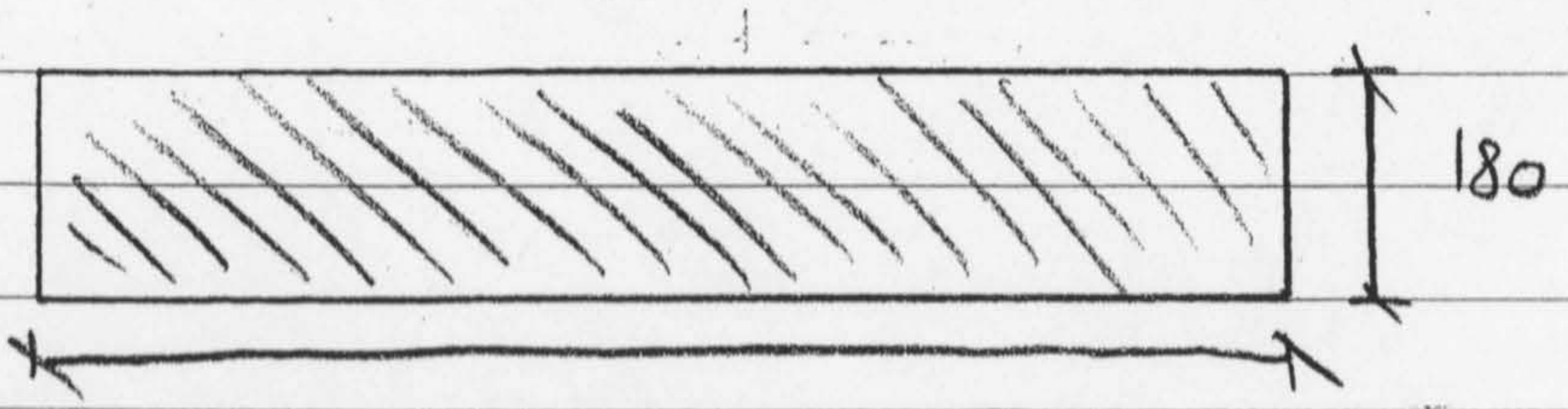
= 420 mm

$$\frac{b_w * h^3}{12} * K$$

$$I_b = \frac{300 * 600^3}{12} * K = 9.504 * 10^9 \ mm^4$$

$$K = 1 + 0.2 \frac{b_E}{b_w}$$

$$= 1 + 0.2 * \frac{1140}{300} = 1.76$$



$$L = \frac{6000}{2} + \frac{6000}{2} = 6000 \ mm$$

$$\frac{L\,t^3}{12}$$

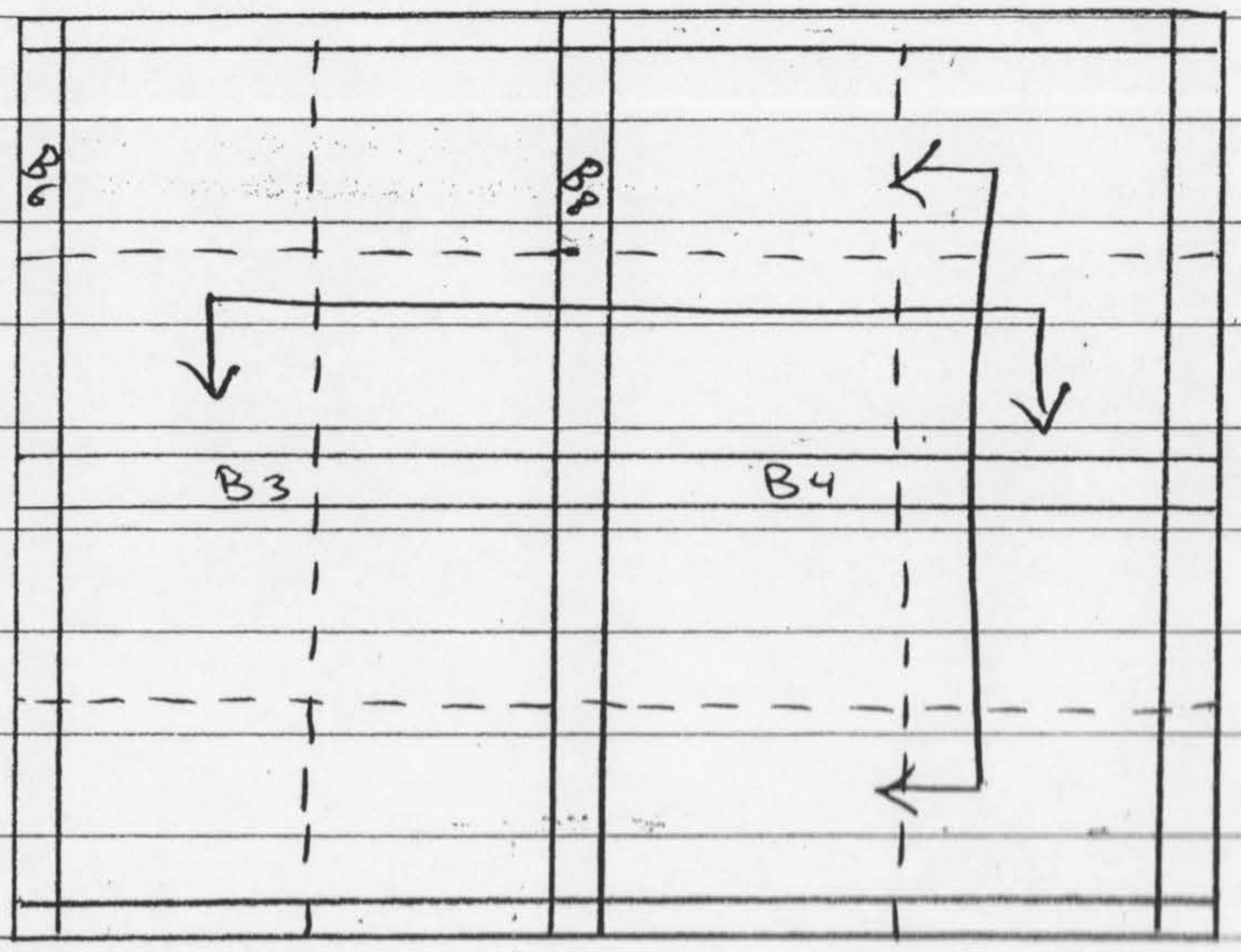
$$I_s = \frac{6000 * 180^3}{12} = 2.916 * 10^9 \ mm^4$$

$$\alpha_{B7} = \frac{I_b}{I_s} = \frac{9.504 * 10^9}{2.916 * 10^9} = 3.26 = \alpha_{B8}$$

Winner Line

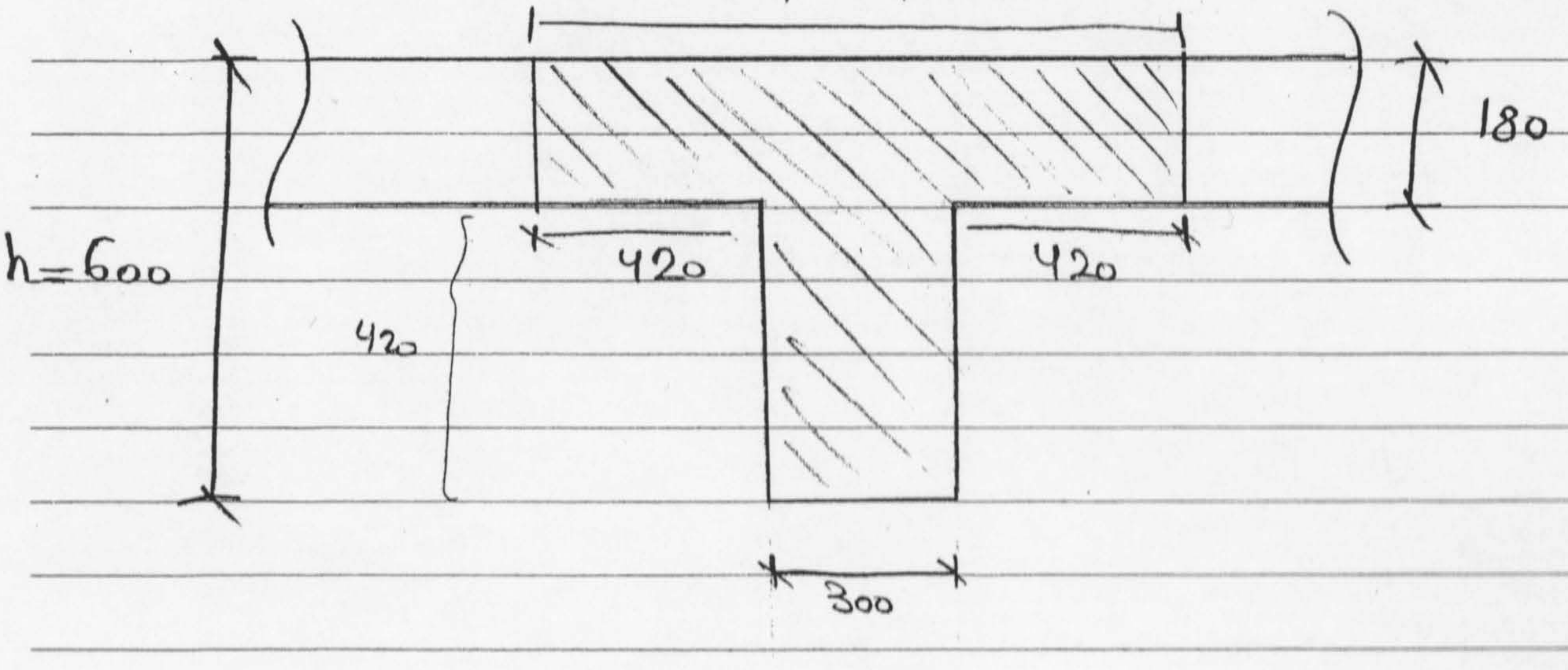
27/10/2015

تكملة المثال السابق



Beam (3) (B3)

$b_E = 420 + 420 + 300 = 1140$



$\frac{b_w * h^3}{12} * K$

$$I_b = \frac{300 * 600^3}{12} * K = 9.504 * 10^9 \ mm^4$$

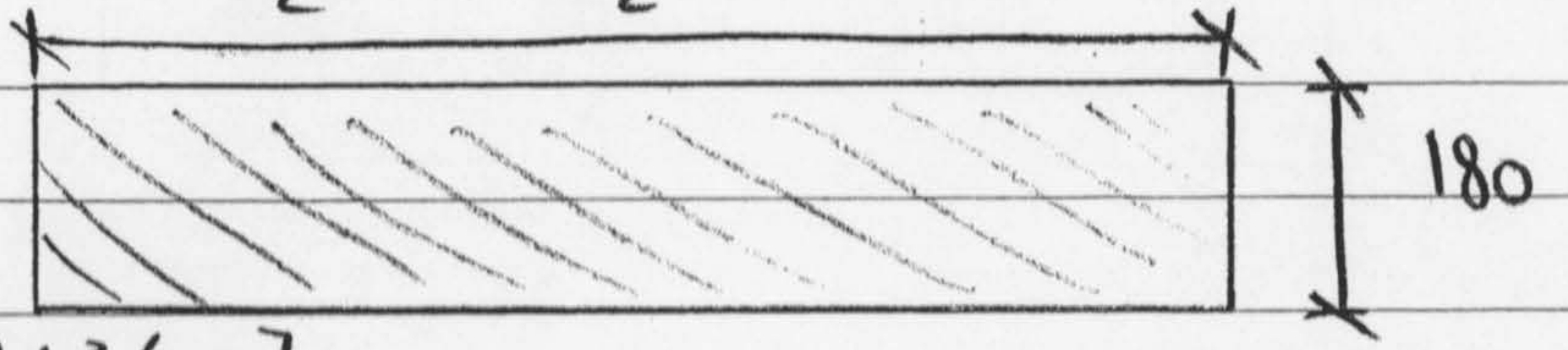
$$K = 1 + 0.2 \frac{b_e}{b_w} = 1.76$$

$$0.2 < \frac{180}{300} = 0.3 < 0.5$$

$$2 < \frac{1140}{300} = 3.8 < 4$$

} شروط (K)

$$L = \frac{8000}{2} + \frac{8000}{2} = 8000$$



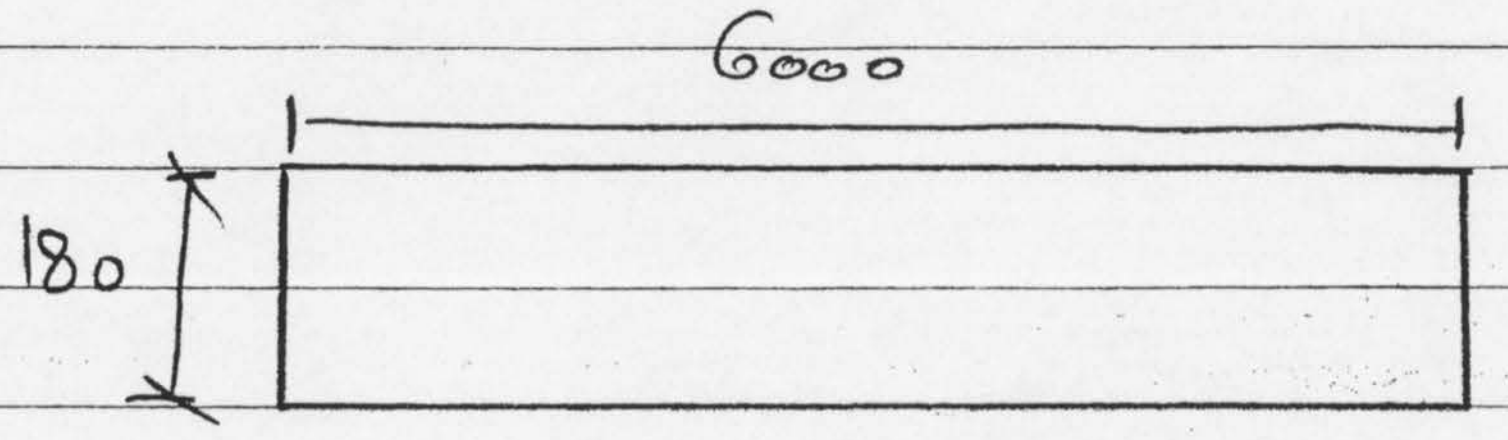
$[Lt^3/12]$

$$I_s = \frac{8000 * 180^3}{12} = 3.888 * 10^9 \ mm^4$$

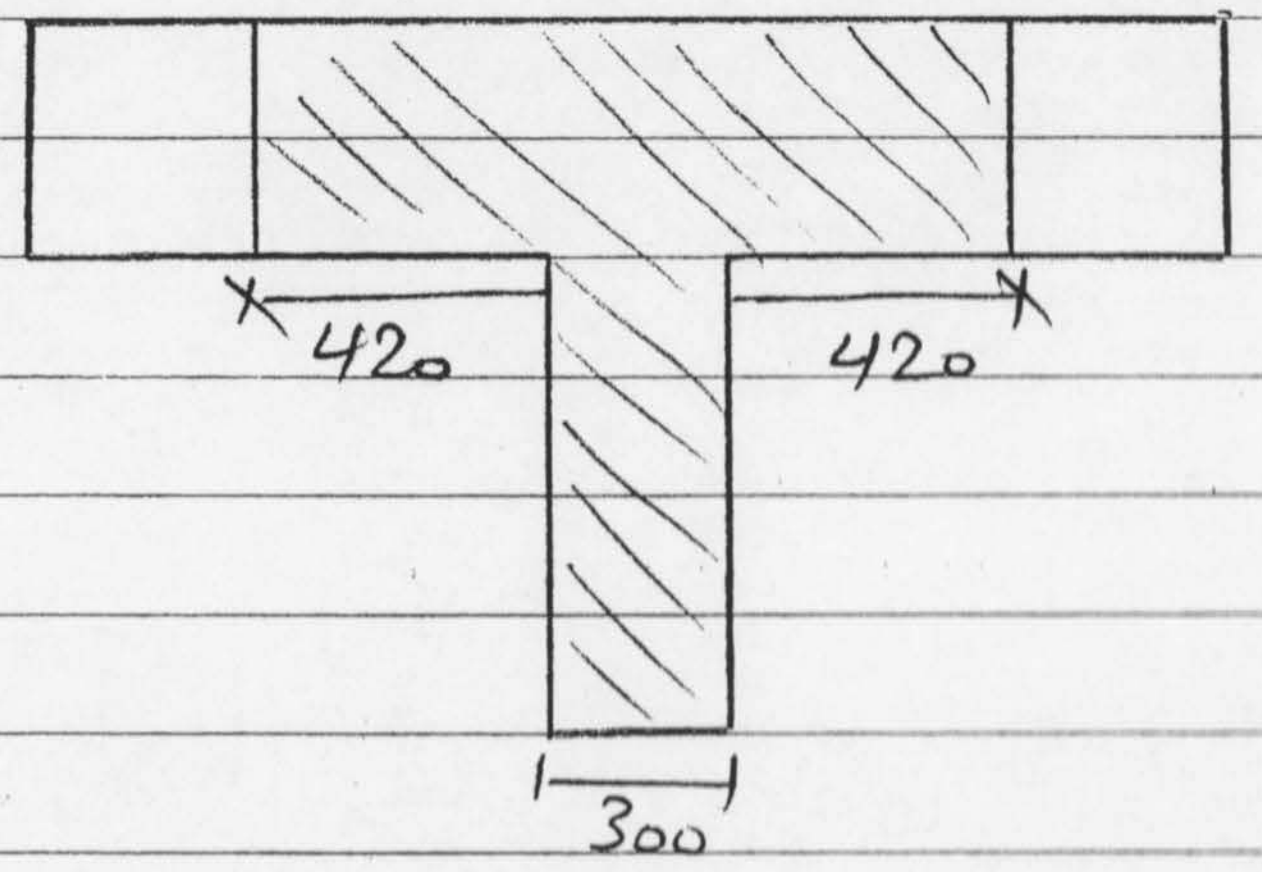
$$\alpha B_3 = \frac{I_b}{I_s} = \frac{9.504 * 10^9}{3.888 * 10^9} = \alpha B_4 = 2.4$$

Winner Line

Beam 6 (B6)



$I_s = 2.96 * 10^9$



$I_b = 9.504 * 10^9$

$$\alpha_{B6} = \alpha_{B8} = \frac{I_b}{I_s} = \frac{9.504 * 10^9}{2.96 * 10^9} = 3.259$$

$$\alpha_{mA} = \frac{\alpha_{B1} + \alpha_{B3} + \alpha_{B5} + \alpha_{B7}}{4}$$

$$\alpha_{mA} = \frac{3.824 + 2.444 + 8.267 + 3.259}{4}$$

$$\alpha_{mA} = 4.448 > 2$$

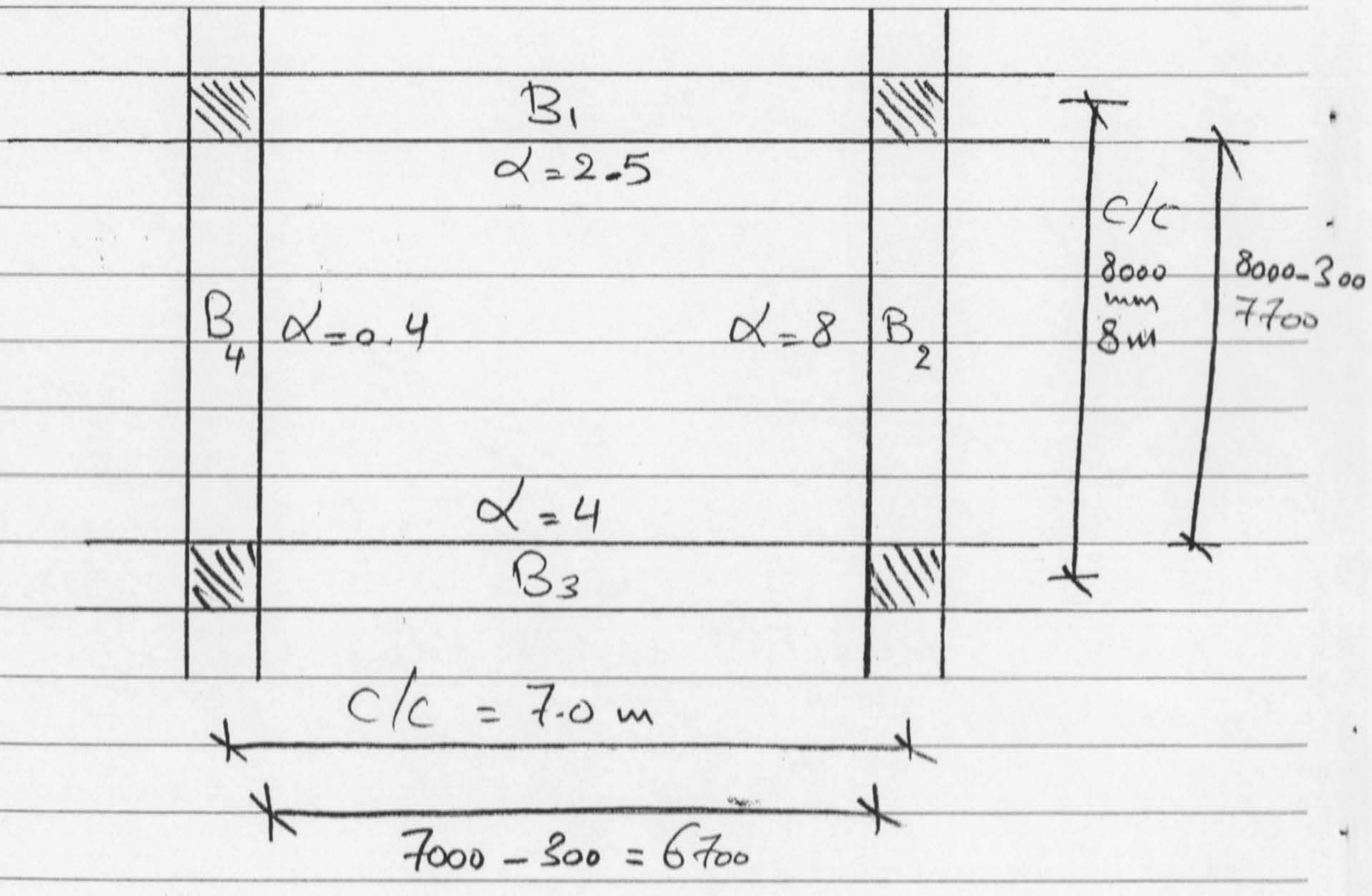
من نجيب السمك من eq (2)

$$t = \frac{L_n \left(0.8 + \frac{f_y}{1400}\right)}{36 + 9\beta} \quad , \beta = \frac{7400}{5400} = 1.37$$

$$= \frac{7400\left(0.8 + \frac{350}{1400}\right)}{36 + 9 * 1.37} = 158.2 \simeq 160 \text{ mm} > 90 \text{ mm}$$

لأن αB_1 و αB_5 < 0.8 فلا تقرب بـ 1.1

Ex: Find Slab thickness for following panel
$f_y = 420$.
all columns 300 * 300



$$dm = \frac{2.5+0.4+4+8}{4} = 3.25 > 2$$

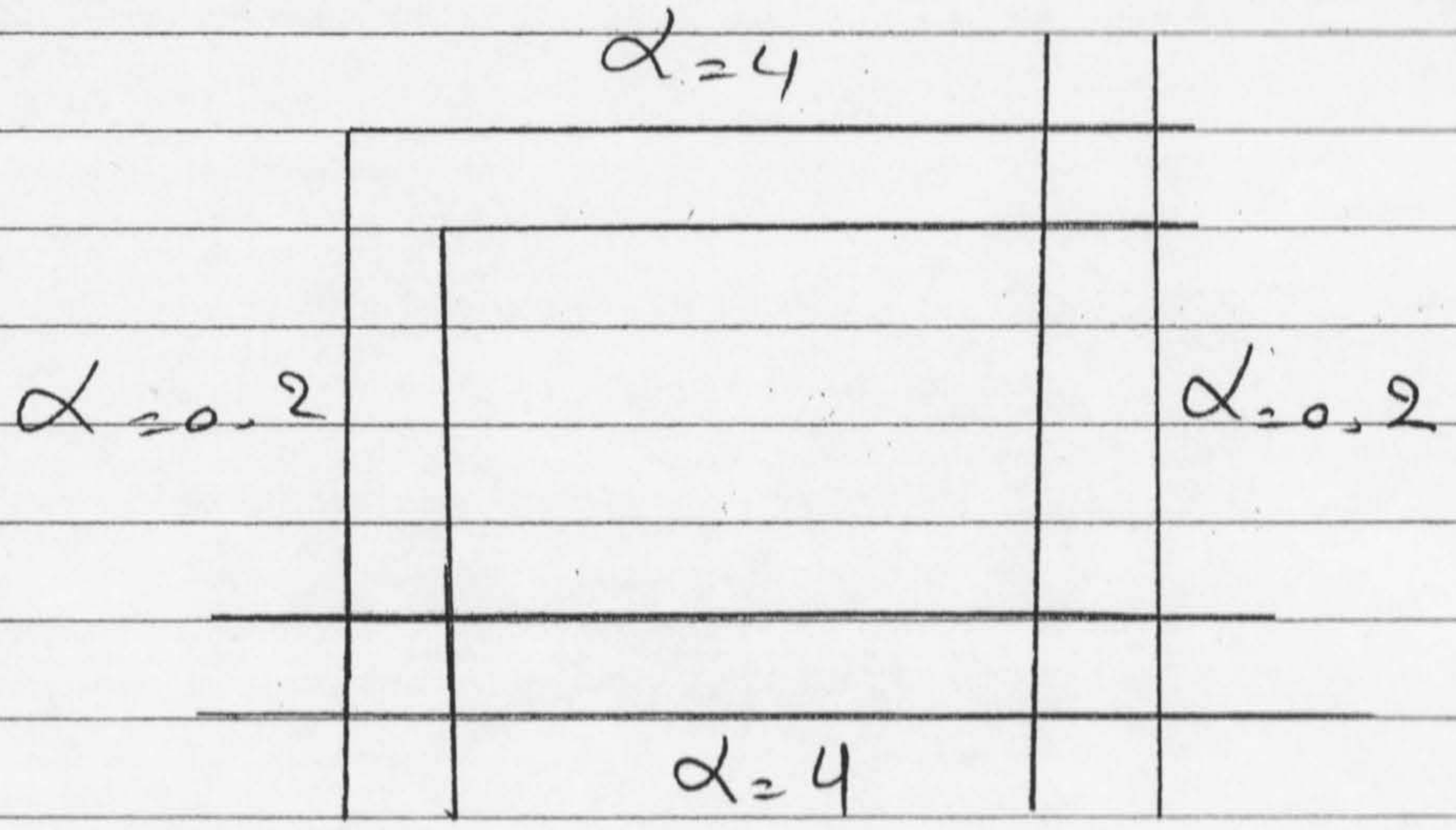
use eq (2)

$$B = \frac{7.7}{6.7} = 1.15$$

ال α لكل البيانات الخارجية أصغر من 0.8

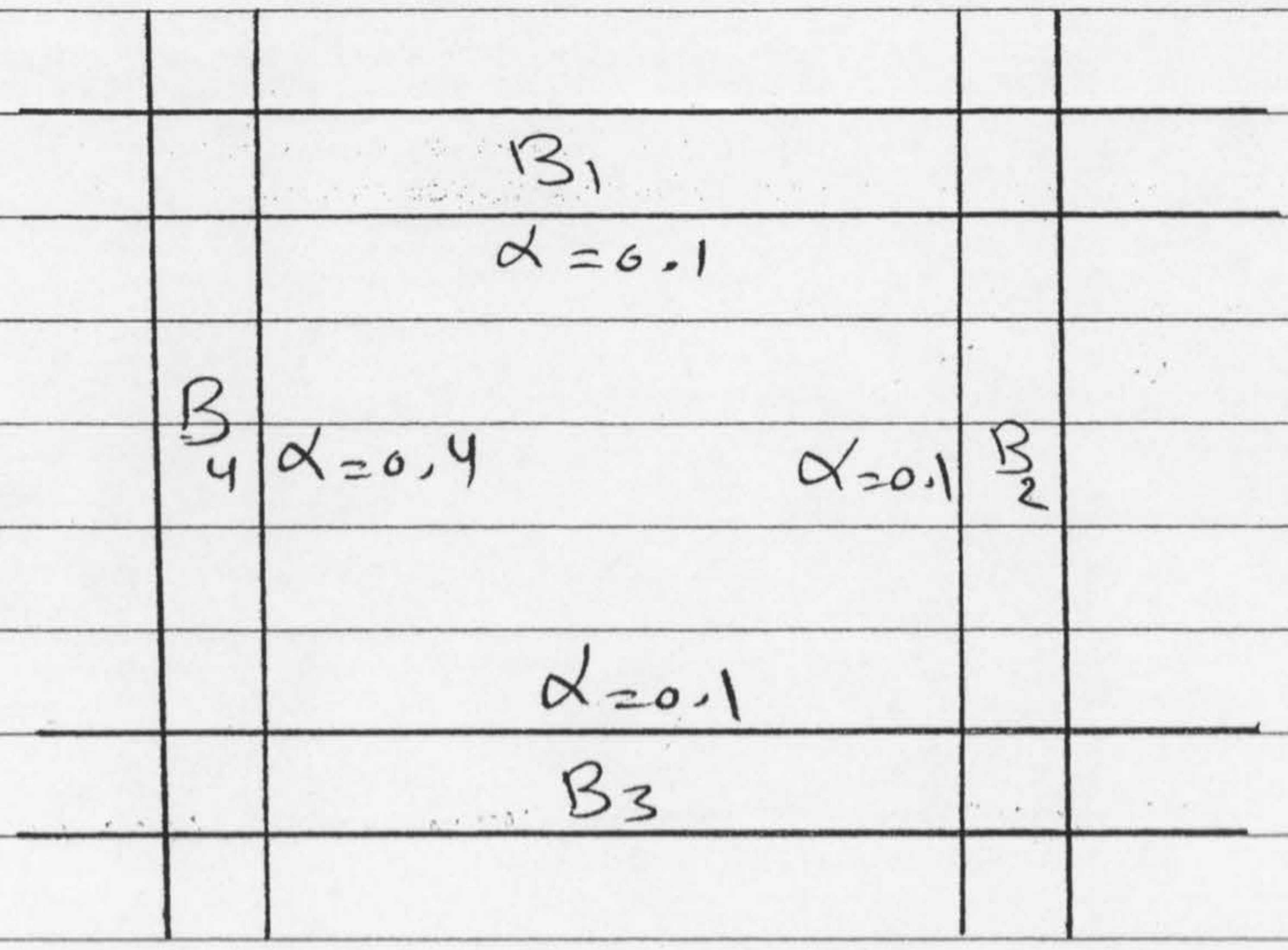
$$t = \frac{7700\left(0.8+\frac{420}{1400}\right)}{(36+9*1.15)} * (1.1) = 178.4 \geq 90$$

$\therefore$ $t = 180 \geq 90$



Ex $f_y = 400$

all columns $= 300 * 300$



$$\alpha_m = \frac{0.1 + 0.1 + 0.1 + 0.4}{4} = 0.175 < 0.2$$

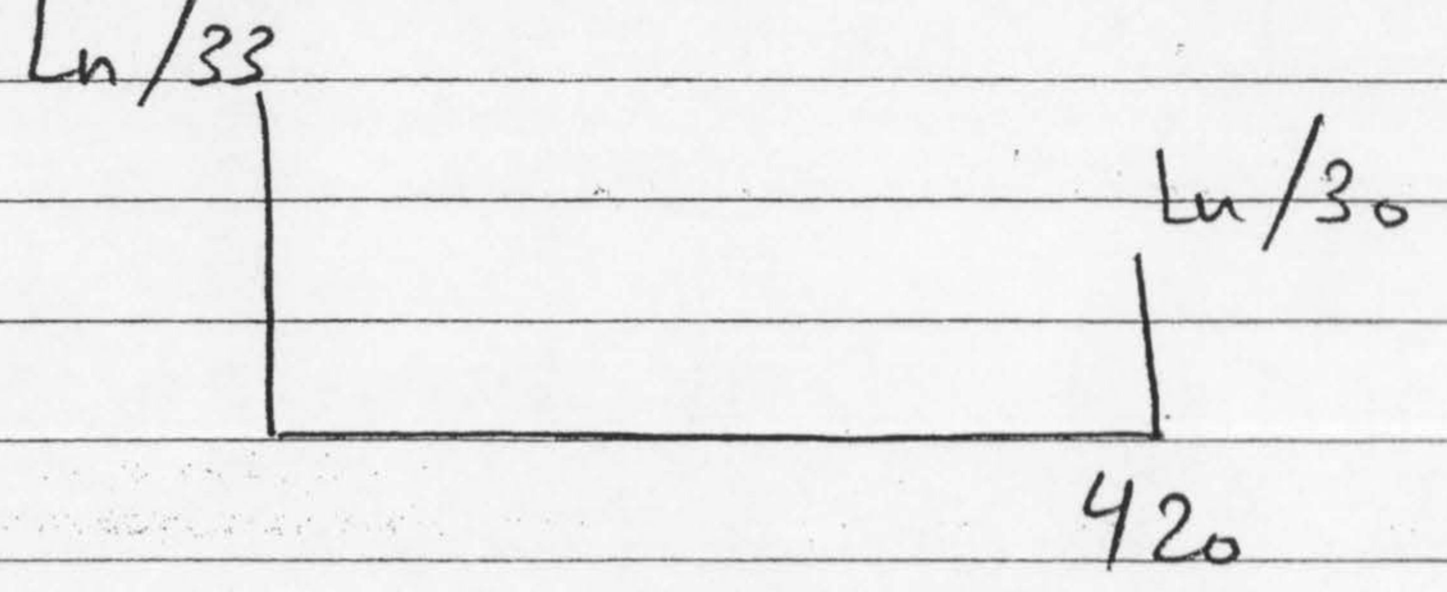
go to table

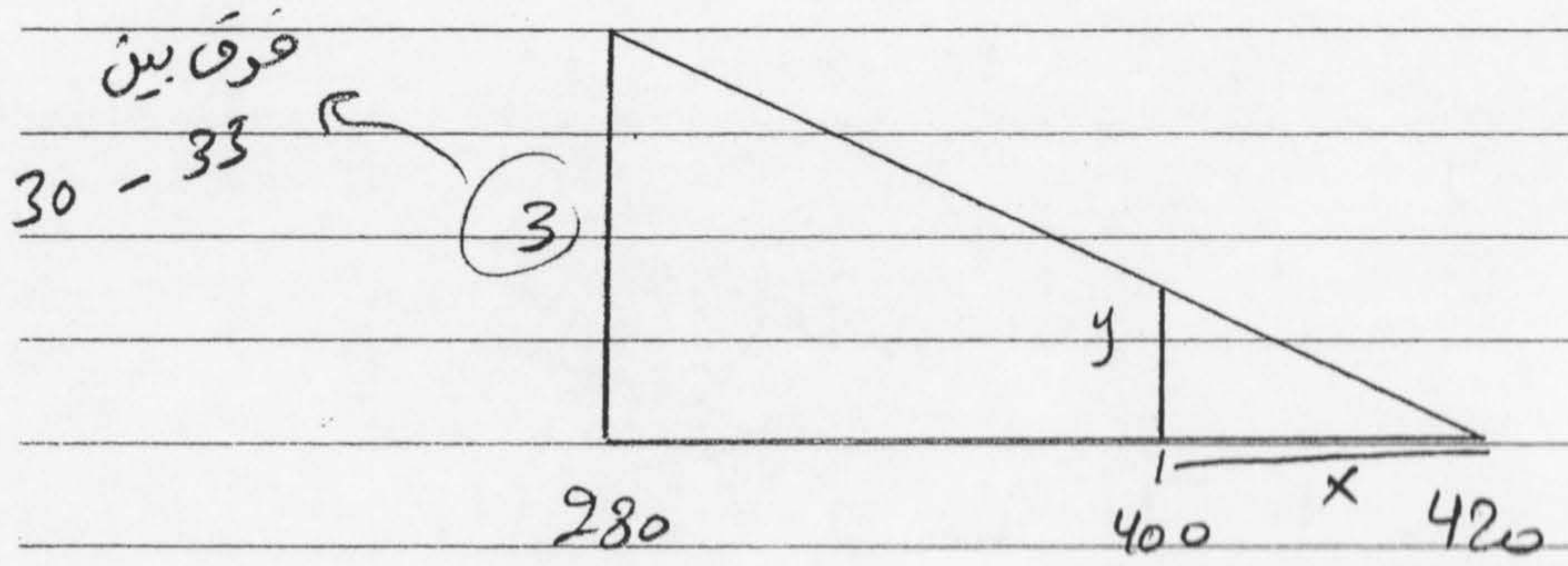
(without drop panel exterior)

يوجد edge beam لكن $\alpha = 0.4$ وهي

اقل من 0.8 لذلك لايعتبر edge beam

نستخدم ال interpolation





$$\frac{y}{3} = \frac{20}{140} \Longrightarrow y = 3 * \frac{20}{140} = 0.428$$

$$t = \frac{Ln}{30 - 0.428} = \frac{7700}{30 - 0.428} = 253.05 > 125$$

$$t = 260$$

Winner Line

3/11/2015

Method of analysis of Slabs

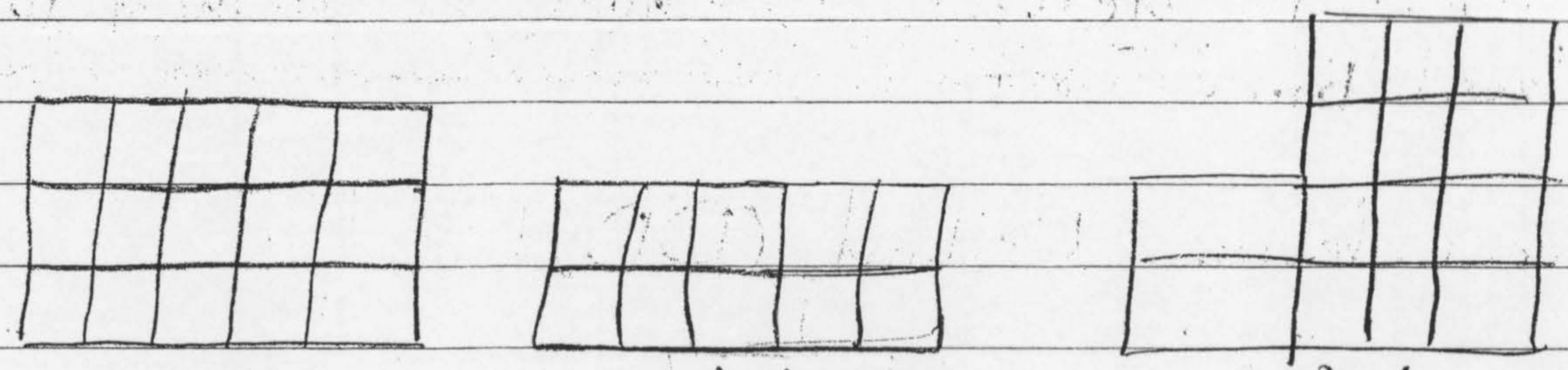
* Coefficient Methods (Method one, Method two, Method three ACI_63)
* 1. Direct design Method (DDM)
* Equivalent Frame Method.
* Finite Element Method (FEM)
* Yield Line Method.

نقل

الموضوع : التاريخ / /

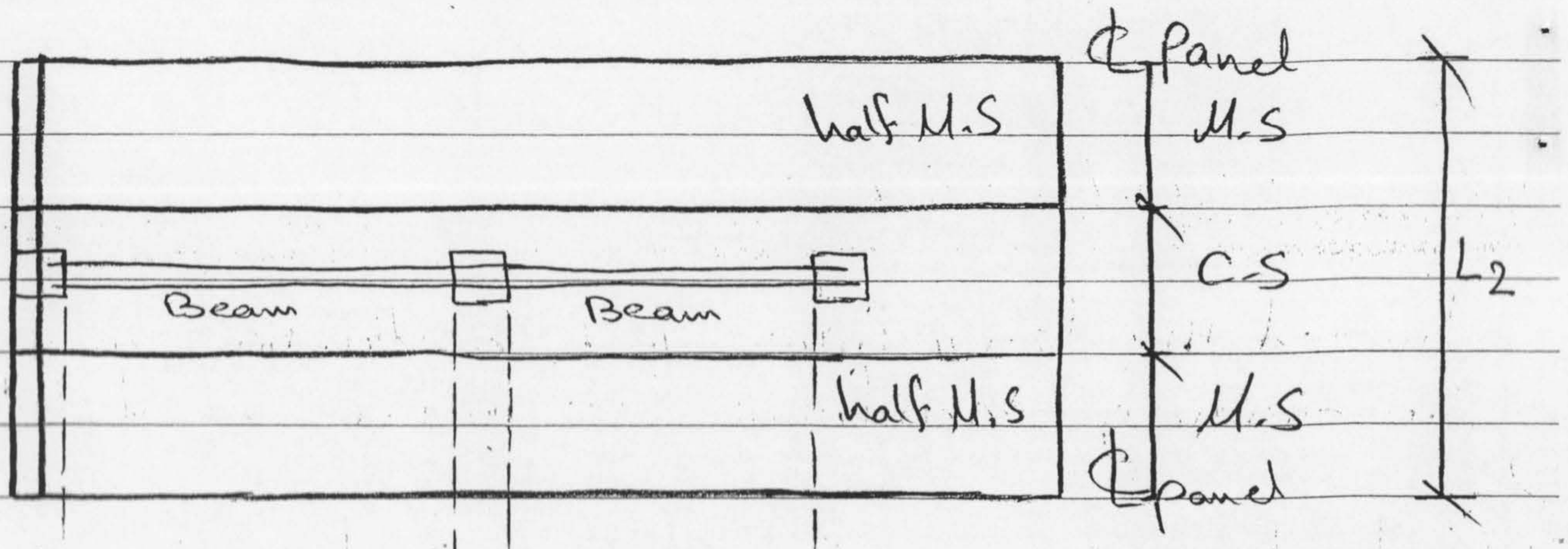
DDM ص P.9 بالملزمة

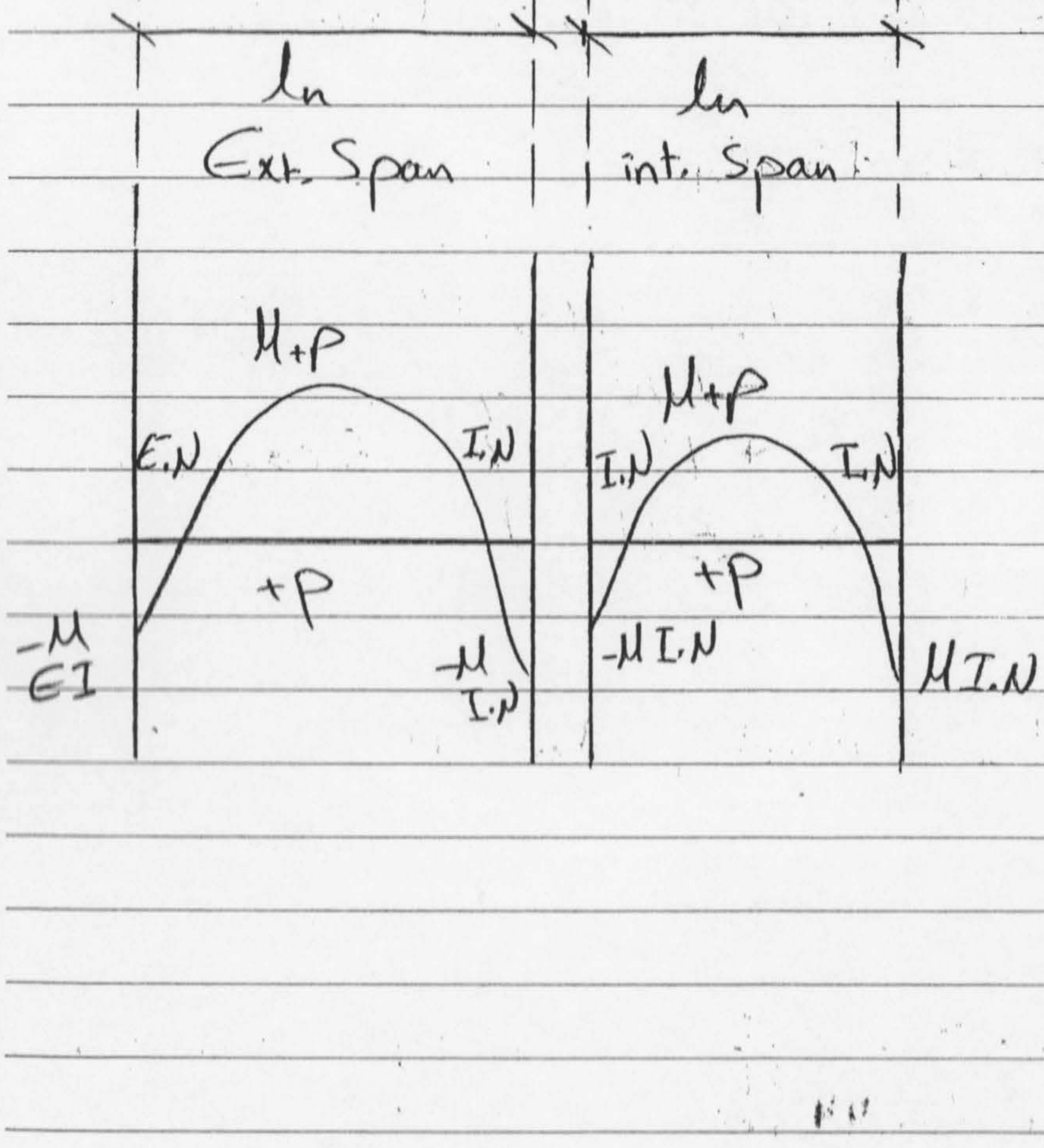
1- There shall be a minimum of three continous spans in each direction.



OK Not OK Not OK

لازم اقل شي ٣ panales بالاتجاه الواحد.





L_1 موازي للشريحة

L_2 عمودي على الشريحة

Procedure of D.D.M

① $W_u = 1.2 D.L + 1.6 L.L$

② divided the slab in frames in both direction and Sub dividing each frame lateraly to C.S and M.S

③ find M_o of each Span. $M_o = \frac{W_u L_2 L_n^2}{8}$

④ divided M_o longitudinally

- MI
  - interior Span
    - P 0.35 M_o
    - I.N 0.65 M_o
  - exterior Span
    - −I.N
    - +.P
    - −E.N

  } 5 cases.

⑤ dividing each $M \mp$ Laterally to Ms. and Cs

$M_{C.S} = \mp M . F_1$

- F
  - I.N table 13.6.4.1
  - +P table 13.6.4.4
  - E.N table 13.6.4.2

For I.N and +P: L_1 c/c of support prependecular to strip; L_2 c/c of support parallel to strip; α.

For E.N: L_1, L_2, α, β

$M_{c.s}$ → M_{beam} ; M_{slab}

$$M_{beam} = M_{c.s} * f_2$$

$$M_{slab} = M_{c.s} - M_{beam}$$

$$f_2 = 0.85 \quad \text{if} \quad \alpha \frac{l_2}{l_1} \geq 1.0$$

$$f_2 = 0.85\, \alpha \frac{l_2}{l_1} \quad \text{if} \quad \alpha \frac{l_2}{l_1} < 1.0$$

(17/12/2015)

التاريخ   /   / ٢٠١   الموضوع :

Example ON D.D.M :-

$W_u = 11\ KN/m^2$ (or) $1.2\,D.L + 1.6\,L.L$

$t = 200$ mm , edge beam $300 * 650$

Find :-

توزيع طولي

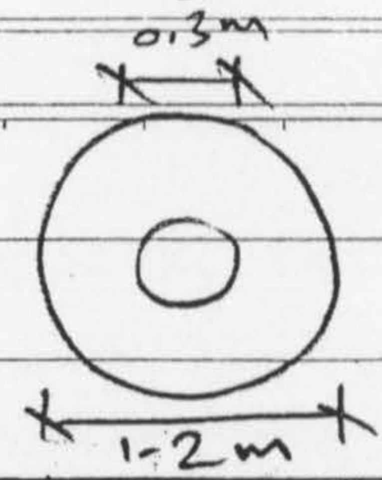
(1) Longitudinal distribution of total Static moment of frame (A)

توزيع عرضي

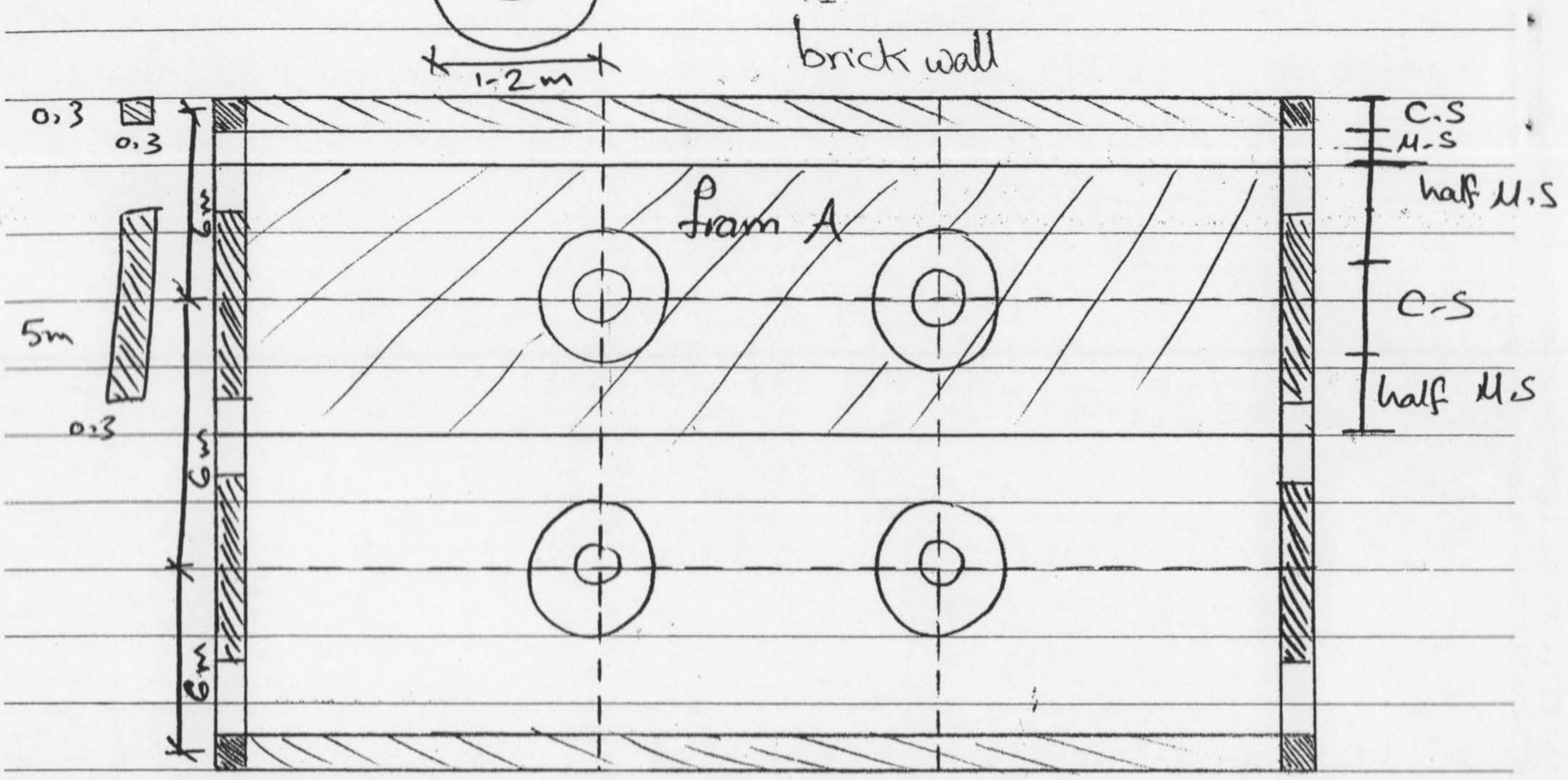
(2) Lateral distribution of moment at exterior support.

(3) Lateral distribution of positive moment in End span. توزيع عرضي للعزم الموجب بتاع الـ span

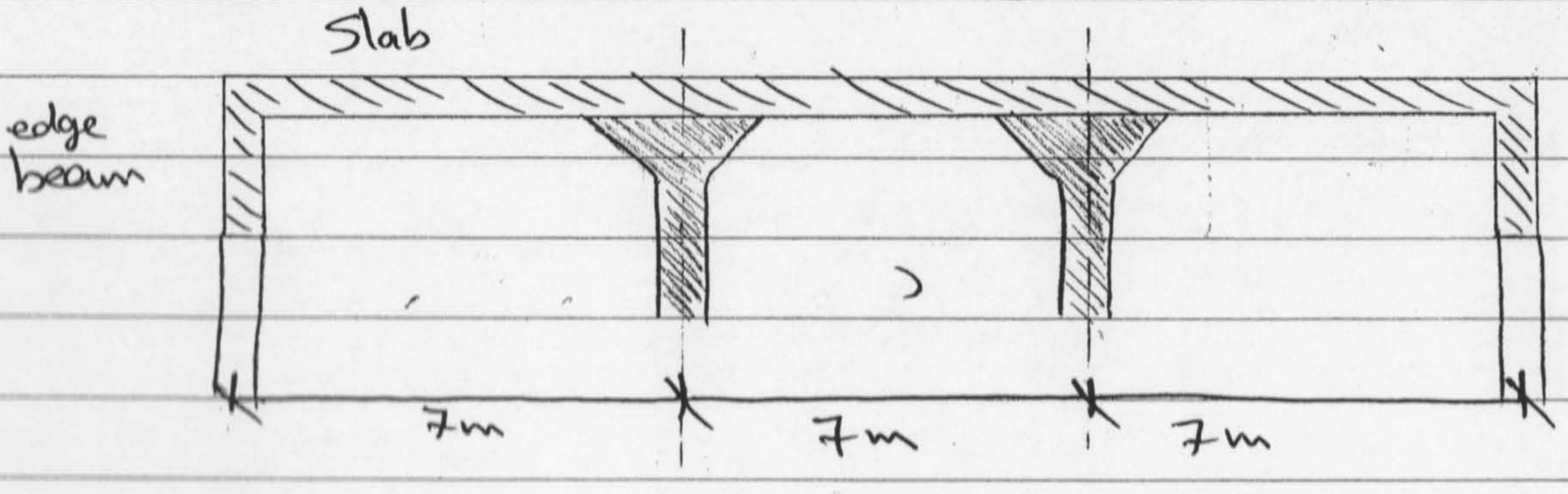
(4) Positive moment in End span of middle strip adjacent and parallel to wall.



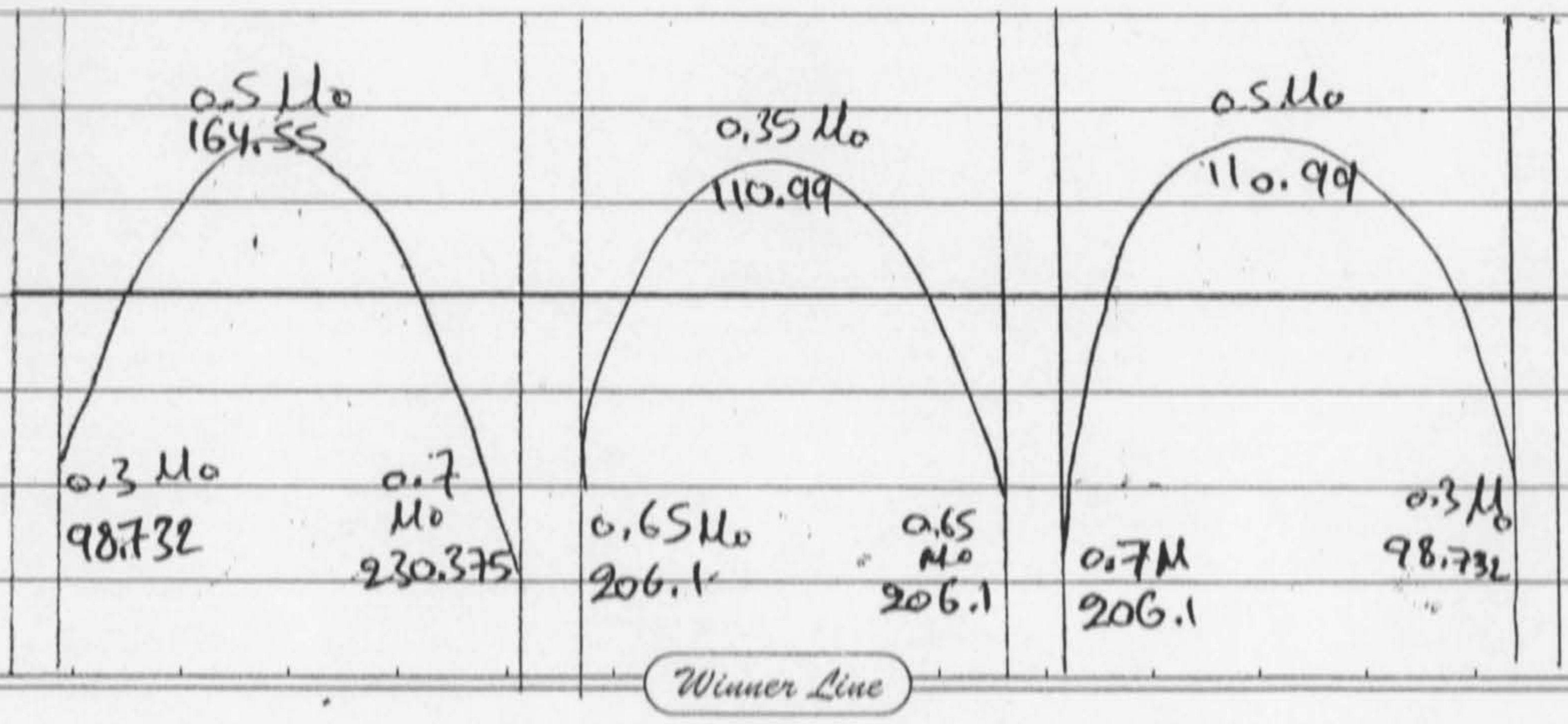
0.3m
1.2m



brick wall
0.3
0.3
5m
0.3
6m
6m
6m
fram A
C.S
M.S
half M.S
C.S
half M.S



Slab
edge beam
7m
7m
7m



0.5 Mo
164.55
0.35 Mo
110.99
0.5 Mo
110.99
0.3 Mo
98.732
0.7 Mo
230.375
0.65 Mo
206.1
0.65 Mo
206.1
0.7 M
206.1
0.3 Mo
98.732

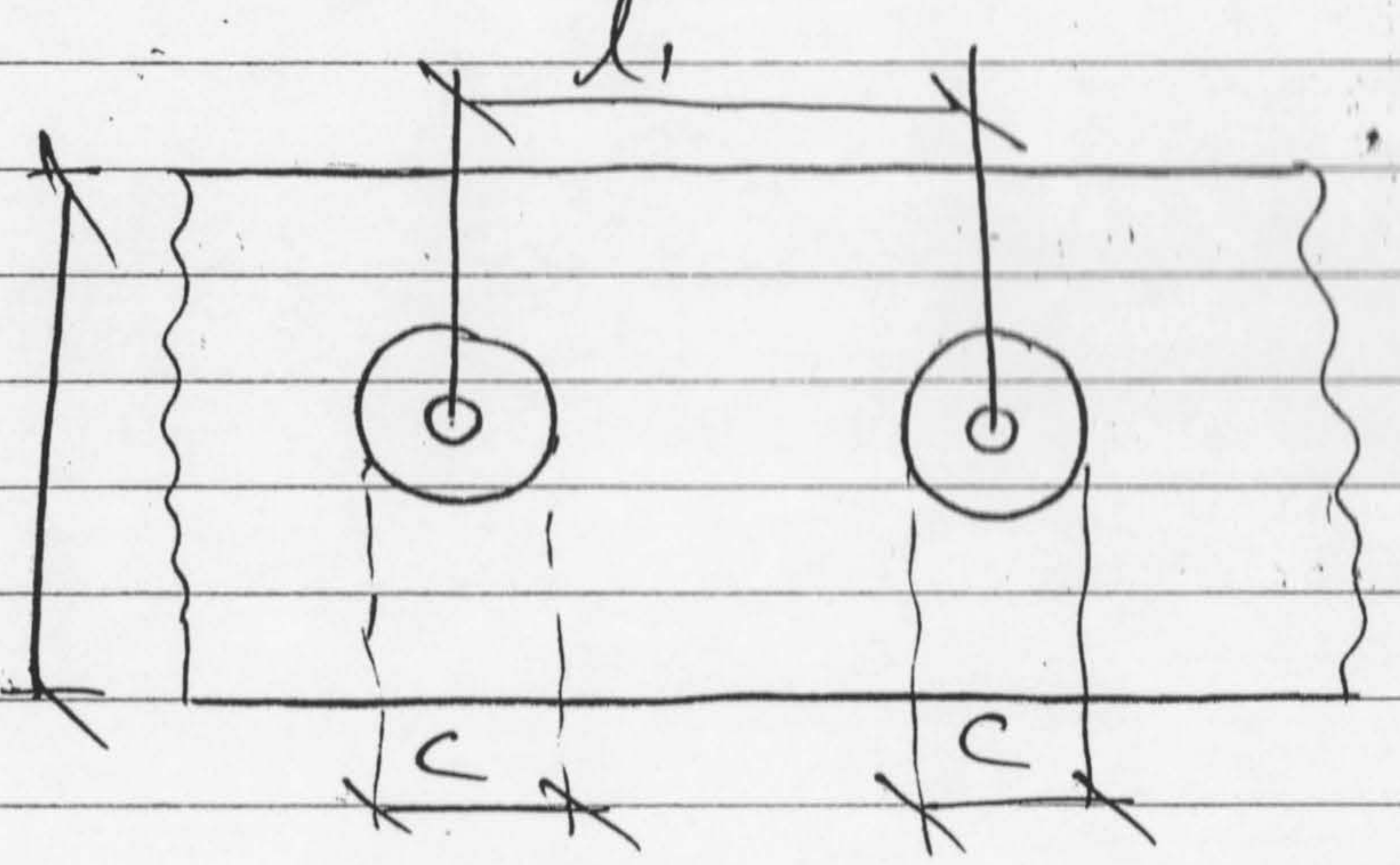
note وفي حالة كون الاعمدة دائرية فان قيمة M_o هي القيمة الاكبر من بين المعادلتين التاليتين .

$$M_o = \frac{W_u L_2 L_n^2}{8} * \left(1 - \frac{2c}{3l_1}\right)^2 \quad \text{—— (1)}$$

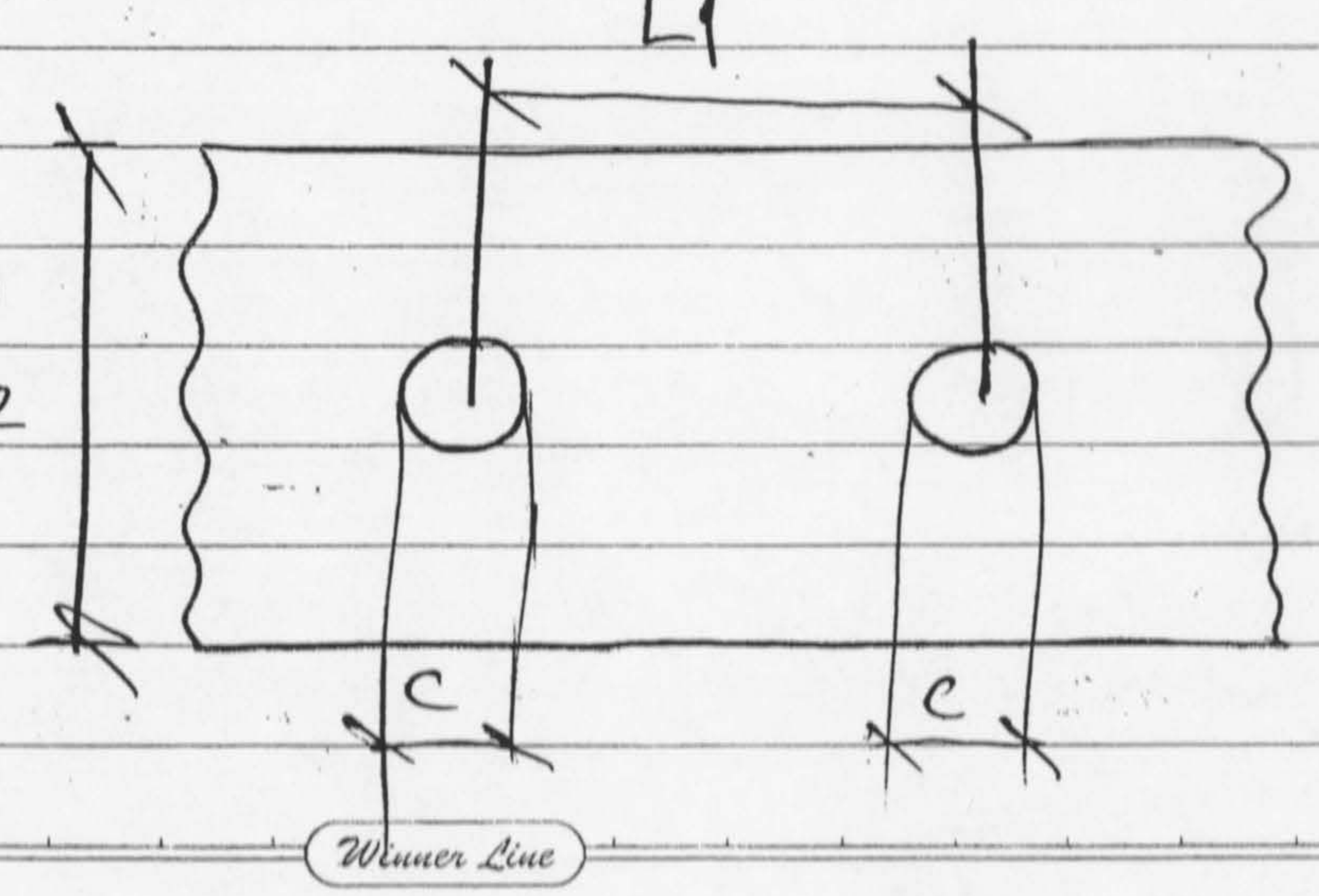
c هو قطر الدائرة الخارجية

$$M_o = \frac{W_u L_2 L_n^2}{8} \quad \text{—— (2)}$$

Column + Capital



Column



Sol :

(1) interior Span

$w_u = 11 \; kN/m^2$

$l_2 = 6 \; m$ عرض الشريحة

$l_n = 7 - \underbrace{0.89 * 1.2}_{\text{طول الـ } L \text{ للركن مربع مكافئ}} = 5.932 \geq 0.65 * 7 = 4.55$

$0.65 \, l_1$

$M_o = \frac{11 * 6 * 5.932^2}{8} * \left(1 - \frac{2 * 1.2}{3 * 7}\right)^2 = 317.13$ ——— (1)

$M_o = \frac{11 * 6 * 5.932^2}{8} = 290.306$ ——— (2)

$\therefore M_o = 317.13 \; kN.m$ ناخذ العزم الأكبر

End (exterior Span)

$w_u = 11 \;, \; l_2 = 6 \;, \; l_n = 7 - \frac{0.3}{2} - \frac{0.89 * 1.2}{2} = 6.316$

$M_o = \frac{11 * 6 * 6.316^2}{8} = 329.107$ ——— (1)

$M_o = \frac{11 * 6 * 6.316^2}{8} * \left(1 - \frac{2 * 1.2}{3 * 7}\right) = 317.13$ ——— (2)

$\therefore M_o = 329.107$

ناخذ منهم factors } end , exterior — الحالة الرابعة
interior — الحالة الخامسة

تنطبق عليه الملاحظة الأولى. } ② { المفروض نوزع ال 98.732 عرضياً ولكن عرض ال column اكبر من $0.75\ l_2$ فلا يوجد توزيع عرضي

$$M_{frame} = M_{c.s} = M_{m.s} = \frac{98.732}{2}$$
$$= 16.455\ KN.m/m$$

فقط في ال Negative نقسمه
والباقي نطلعه M.s و Cs
مختلفة

(3) $L_1 = 7$, $L_2 = 6$, $\alpha = 0$ ⟶ frame ماكو بيم بالـ

$\frac{L_2}{L_1} = \frac{6}{7} = 0.85$

نروح على جدول الـ Positive
ومن نلگة الـ β.

0.5	0.85	1.0
60	60	60

exterior الفرع الموجب الي بالـ

$M_{c.s} = 164.55 * 60 = 98.73$

$M_{m.s} = M - M_{c.s}$

$M_{m.s} = 164.55 - 98.73 = 65.82$

$\text{half m.s} = \frac{65.82}{2} = 32.91$ (اكو half لأن الابعاد متساوية من الجهتين)

(4) نجي ع الـ middle strip الموازي للـ wall الـ

الطريقة الثالثة

$L_n = 0$ (دائماً بال wall = صفر)

half m.s = 32.91

$M_{m.s} = 32.91 * 2 = 65.82$

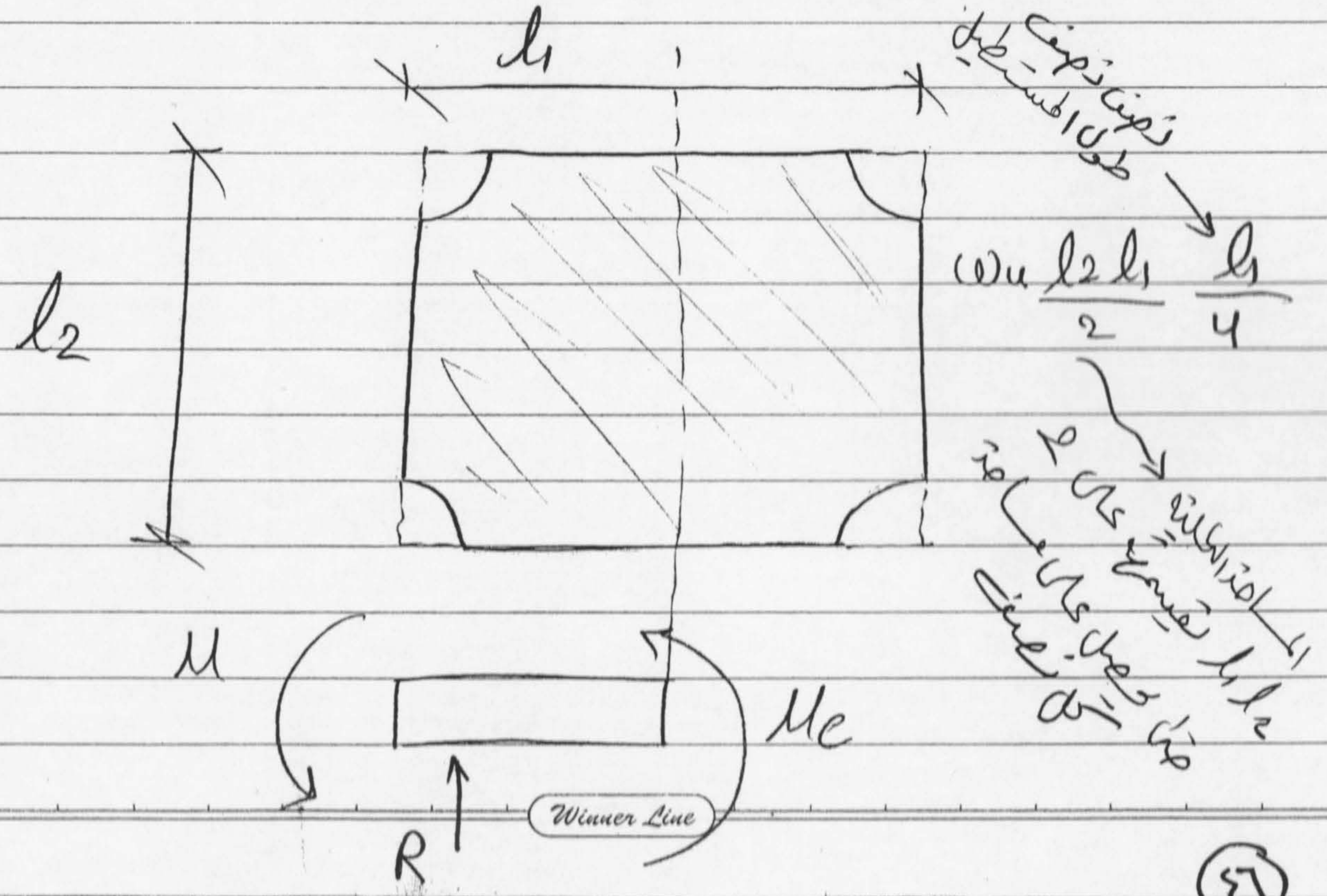
وهاي نشغلها ع الجهتين

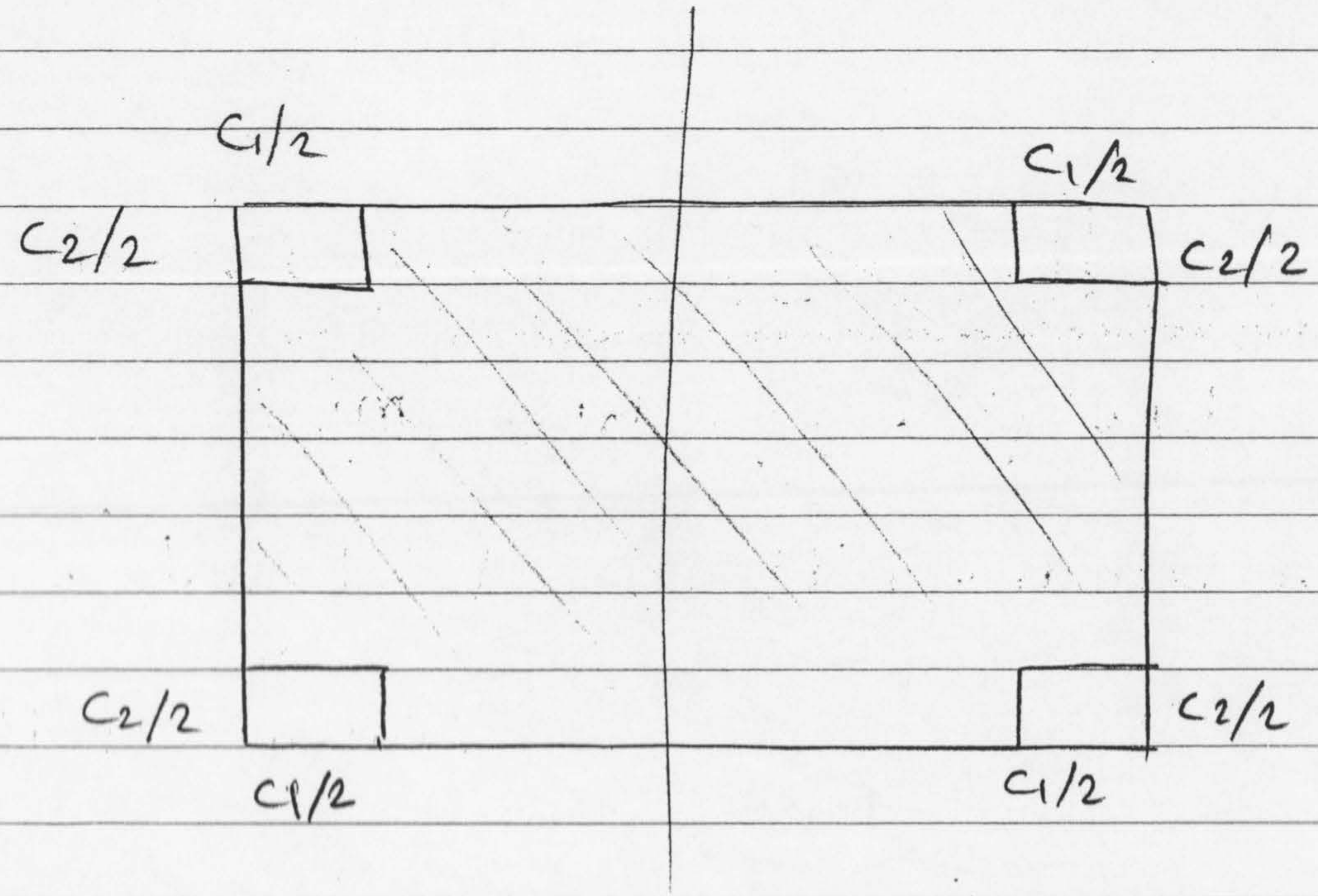
Exact Solution

اخذ الشكل كلة واخذ من كل كولوم ربع دائرة

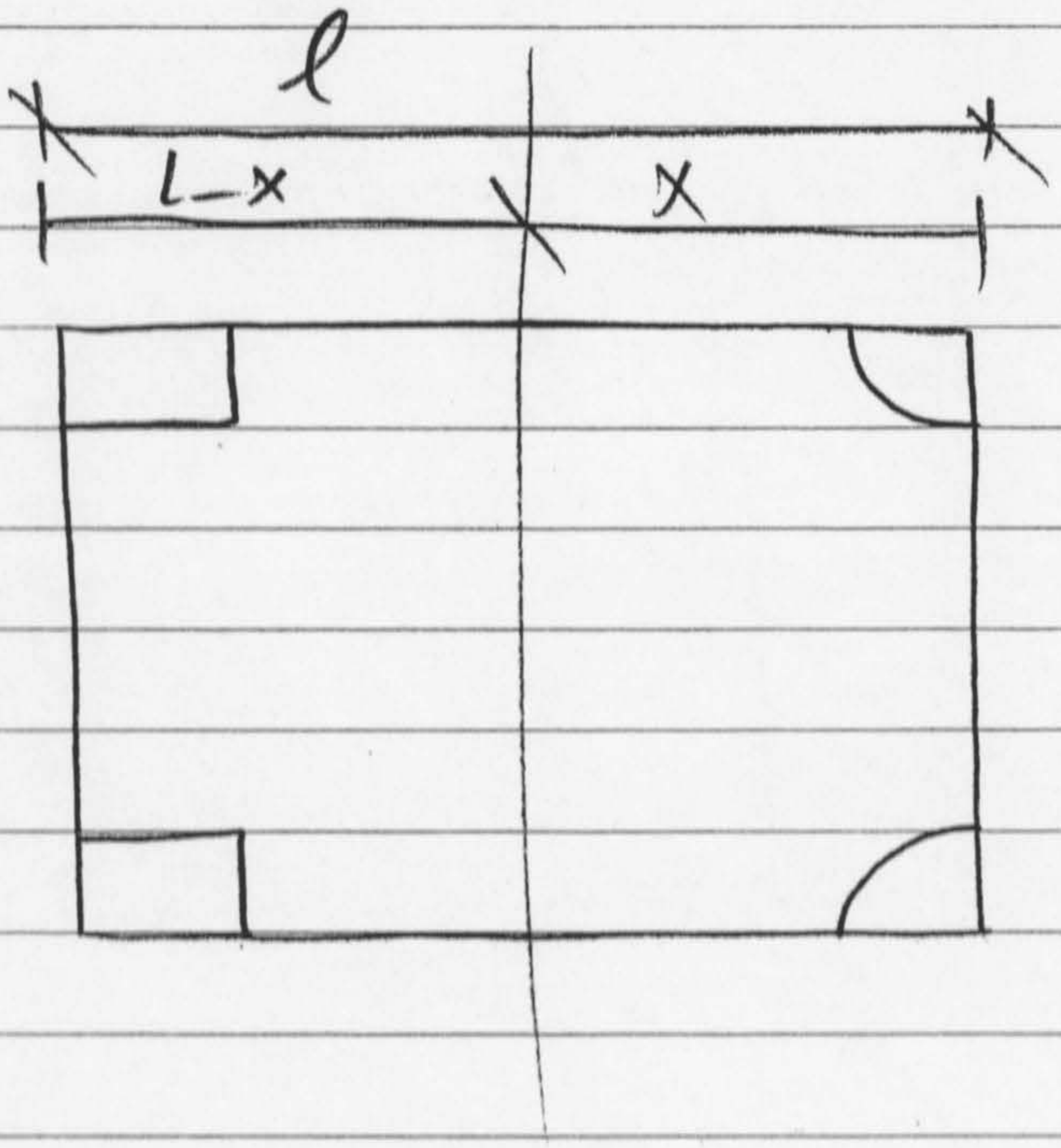
يعني ربع محدد.

بعدين اخذ نصف ال Pannel





* اذا عندي من جهة مربع ومن جهة دائري



Note

اذا طلع العزم صغير تاخذ ال
minimum reinf. واذا طلع العزم قليل
والتسليح اقل من ال min. reinf. فتاخذ
ال minimum.

concret

22/12/2015

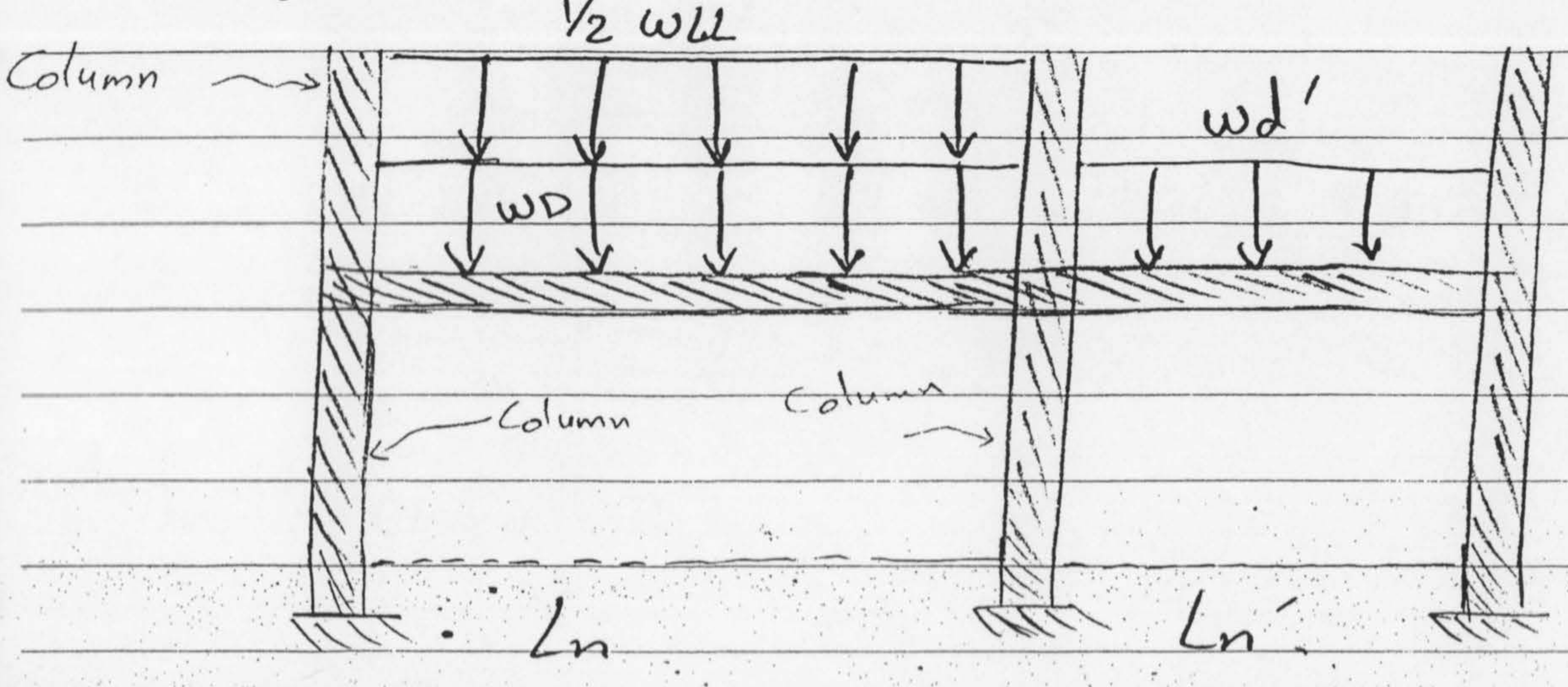
التاريخ / / ٢٠٠

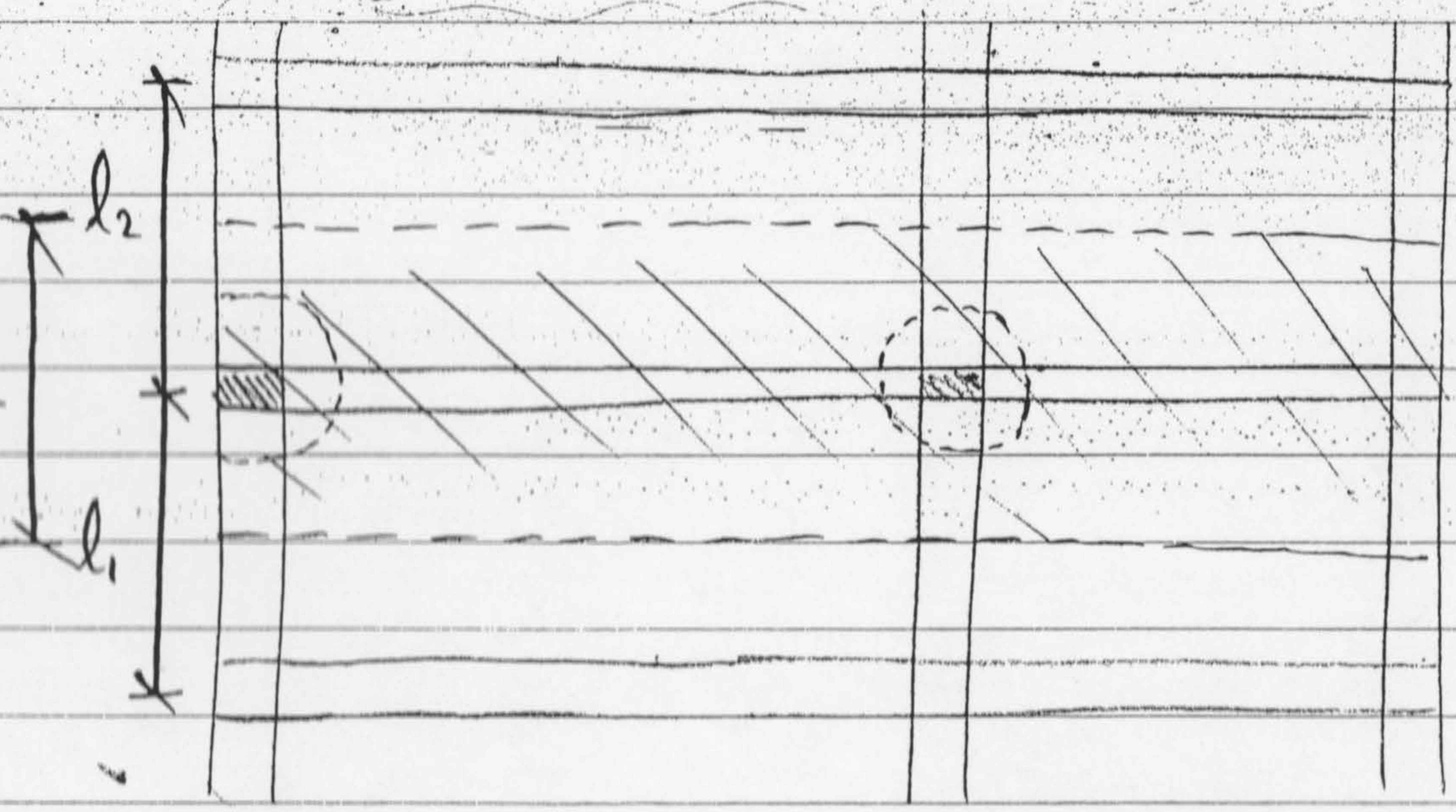
مكتبة الناسخ
استنساخ - قرطاسية - هدايا

Moment in Columns:

according to D.D.M

$L_n > L_n'$



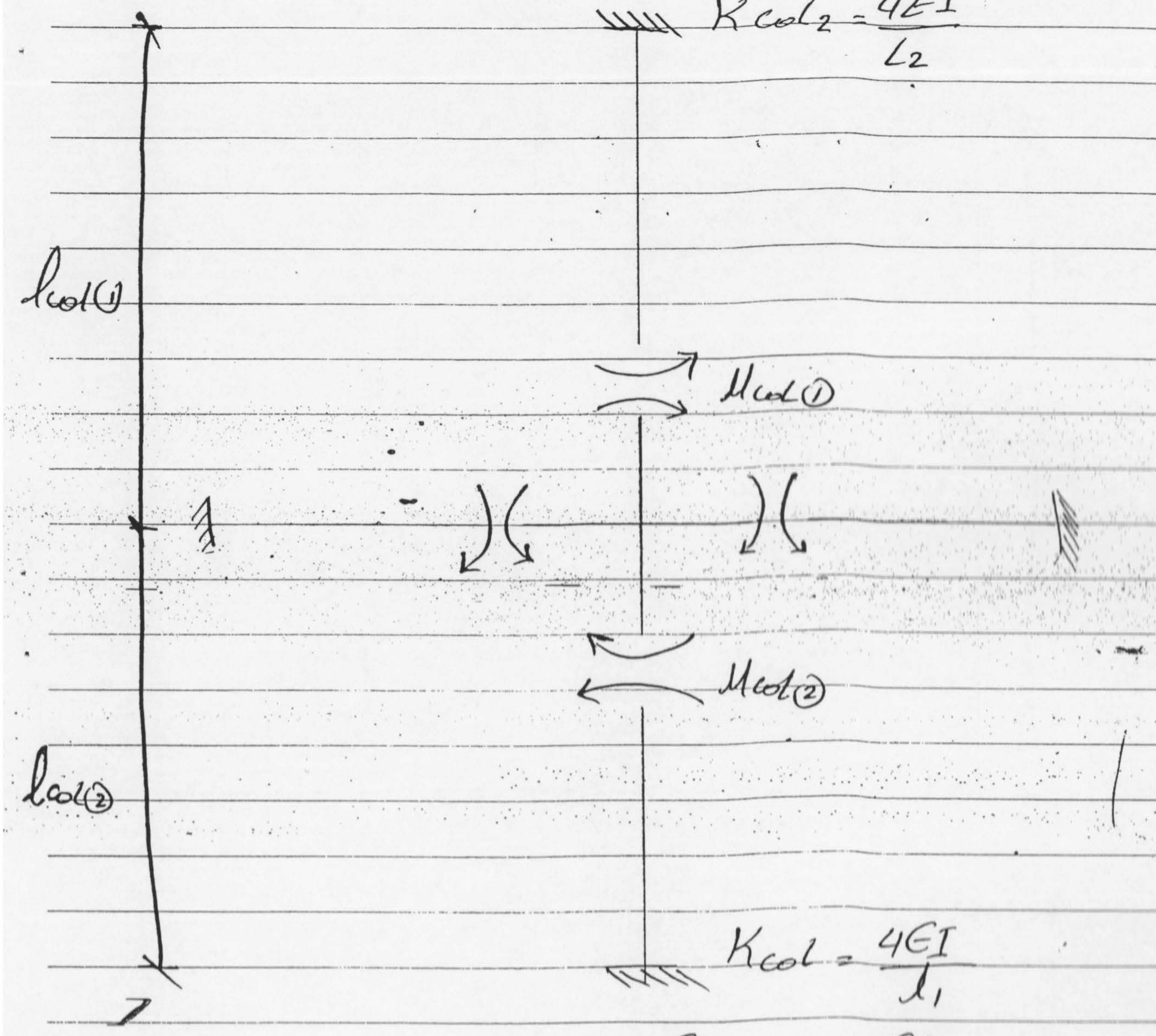


$$M = 0.07\left[\left(w_d + \frac{1}{2} w_L\right) L_2 L_n^2 - w_d' \, l_2' \, (l_n)^2\right]$$

for interior Column

$$M = 0.07\left[\left(w_d + \frac{1}{2} w_L\right) l_2 \, l_n^2\right]$$

for exterior Column



$$\Sigma K = \frac{4EI_1}{l_1} + \frac{4EI_2}{l_2}$$

$$M_{col(1)} = \frac{4EI_1/l_1}{\Sigma K} \quad , \quad M_{col(2)} = \frac{4EI_2/l_2}{\Sigma K}$$

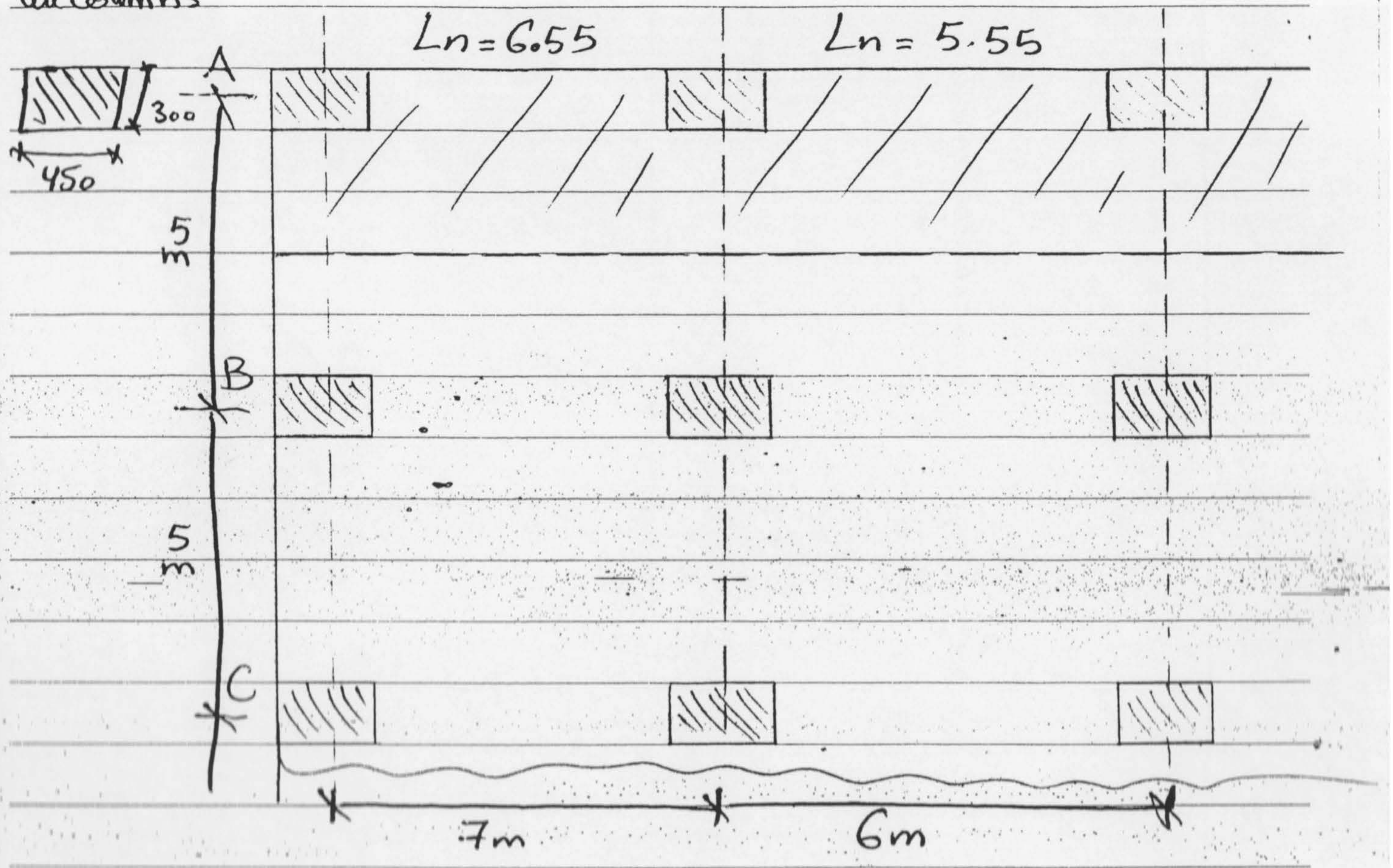
29/12/2015

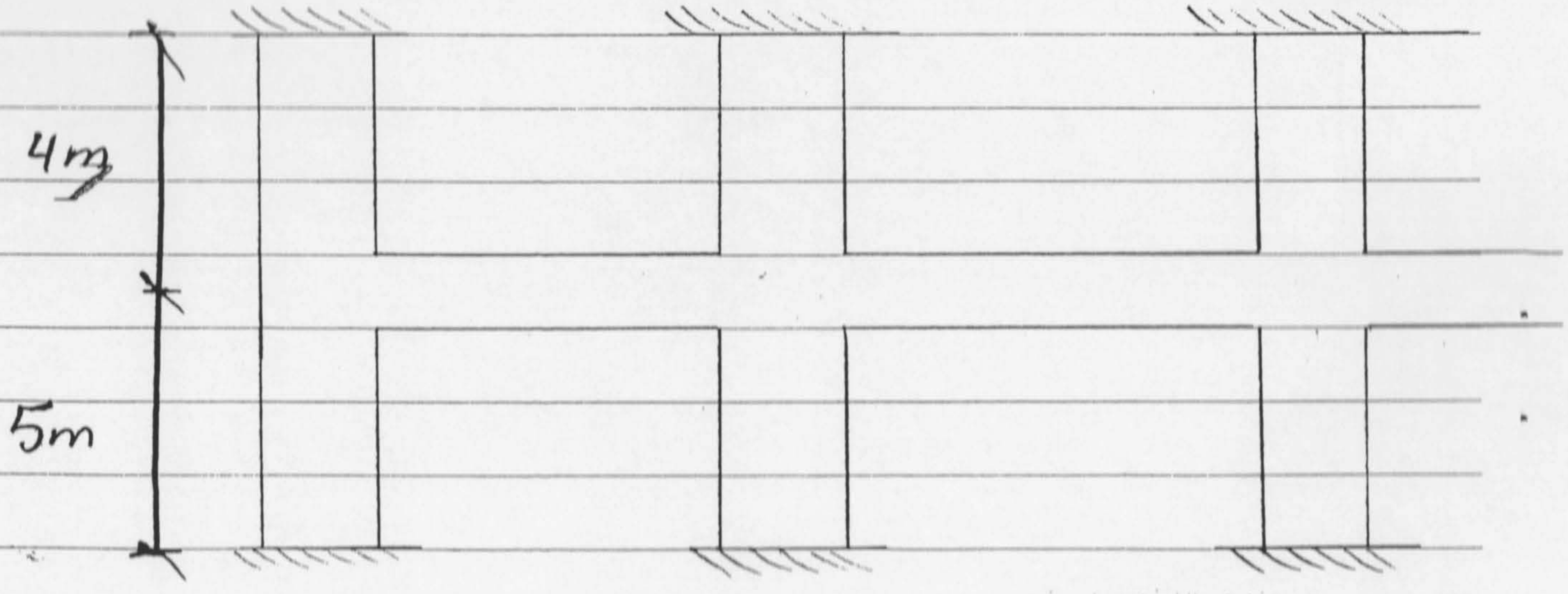
الموضوع :   التاريخ / / ٢٠

Ex3 - Find the Factored moment in columns A_1 and A_2 in the x direction only.

$wd = 8.16 \ KN/m^2$, $wl = 5.31 \ KN/m$

all columns





Winner Line

* الـ Col A هو عبارة عن 2 Col لان واحد فوق وواحد جوه لو عندنا سكشن للسطح فهو كولوم واحد بس.

(A1)

$l_2 = \frac{5}{2} + \frac{0.3}{2} = 2.65$, $l_n = 7 - 0.45 = 6.55$

$M = 0.07\left[(w_d + \frac{1}{2} w_l)\, l_n^2 l_2 + w_d' l_n'^2 l_2'\right]$

علاوة لانه بس من جهة واحدة

$M = 0.07\left[(1.2 * 8.16 + \frac{1}{2} * 1.6 * 5.31) * 2.65 * 6.55^2\right]$

$M = 111.67$ KN.m

$K_{col} = \frac{4EI}{l}$

$K_{col\,A\,top} = \frac{4}{4} = 1$, $D.S = \frac{1}{1.8} = 0.55$

$K_{col\,A\,bottom} = \frac{4}{5} = 0.8$, $D.S = \frac{0.8}{1.8} = 0.45$

$\Sigma = 0.8 + 1$
$= 1.8$

$M_{col\,up} = 111.67 * 0.55 = 61.4$

$M_{col\,bottom} = 111.67 * 0.45 = 50.24$

(A2)

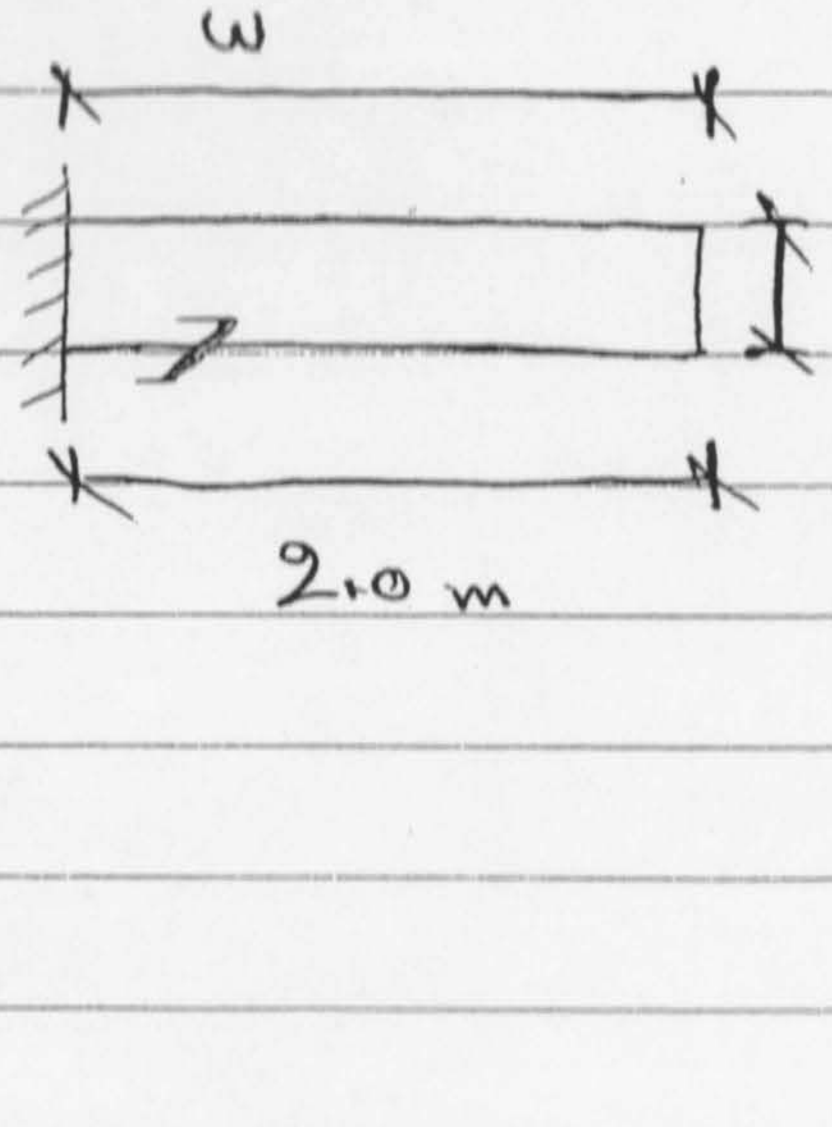
$M = 0.07\left[(1.2 * 8.16 + 1/2 * 1.6 * 5.31)\, 2.65 * 6.55^2 - (1.2 * 8.16)(2.65)(5.55)^2\right.$

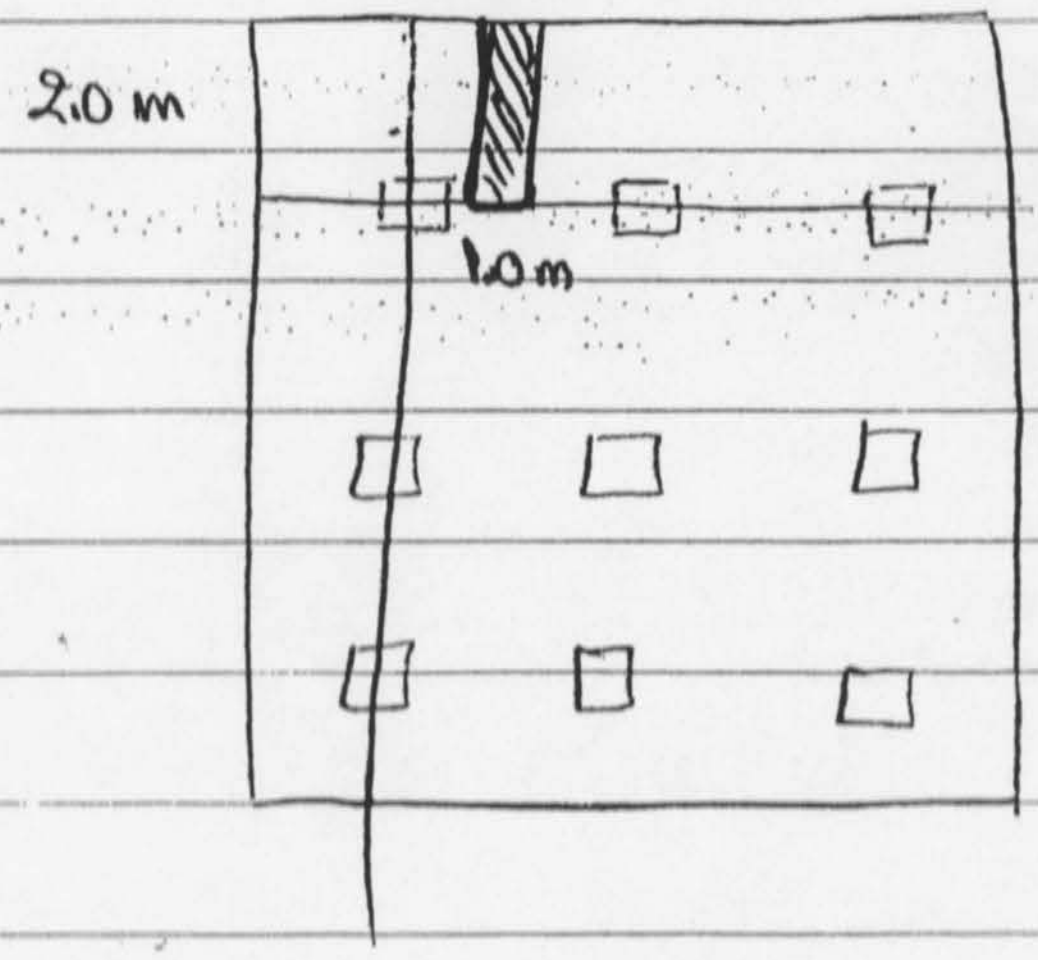
$M = 55.71$

$M_{col\ top} = 55.71 * 0.55 = 30.64$

$M_{col\ buttom} = 55.71 * 0.45 = 25.1$

* اذا عندي Cantliver beam





"Shear"

one way shear

$V_u = \omega\left(\frac{l_1}{c} - d\right) * 1.0$

$V_c = 0.17 \sqrt{f_c}\, b_w\, d$

$\phi V_c = 0.75\, V_c$

$d_{short} = t - 20 - 0.5\, d_b$

$d_{long} = t - 20 - d$

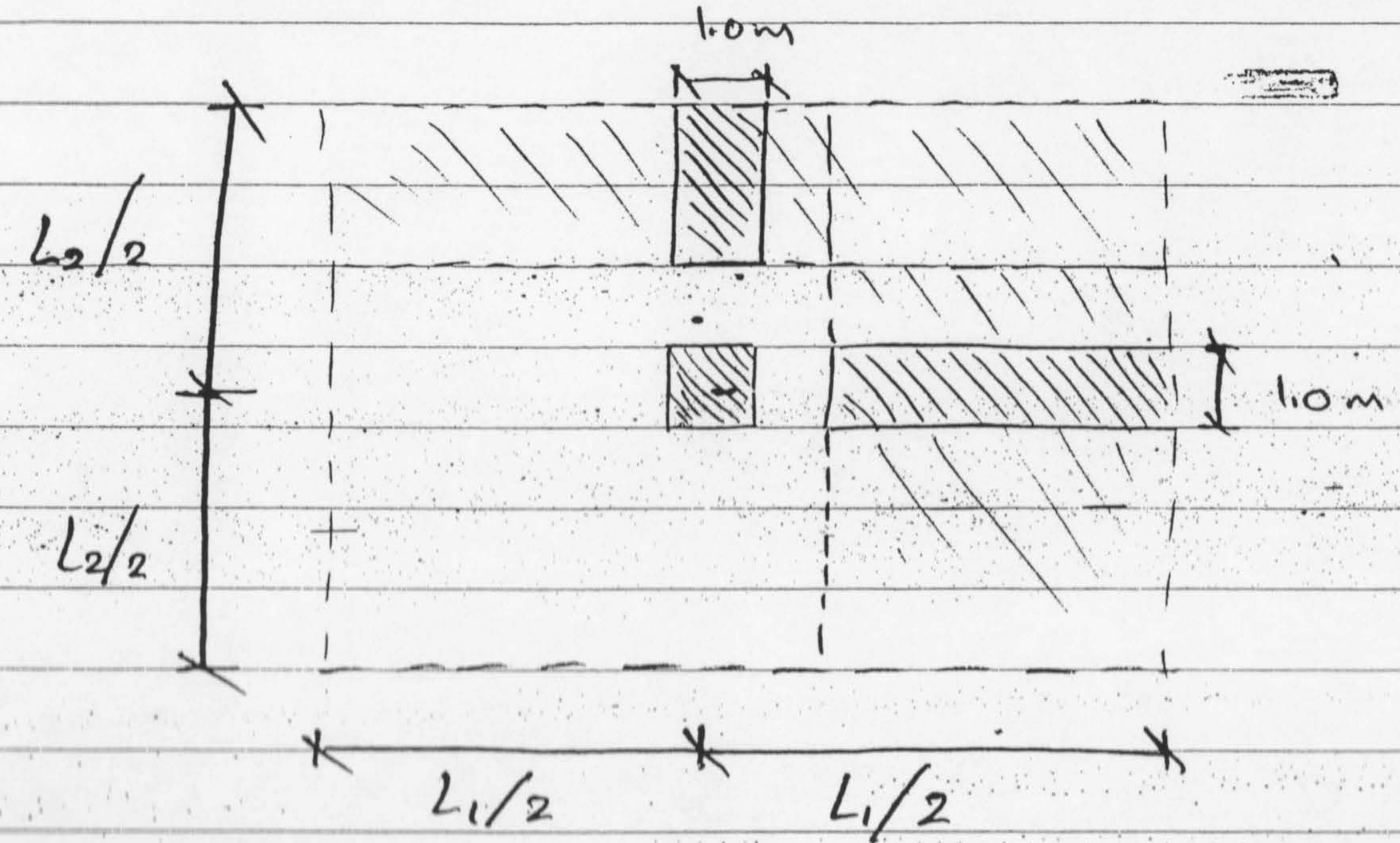
$V_u \leq \phi V_c \therefore$ OK

$V_u > \phi V_c$ → increase thickness

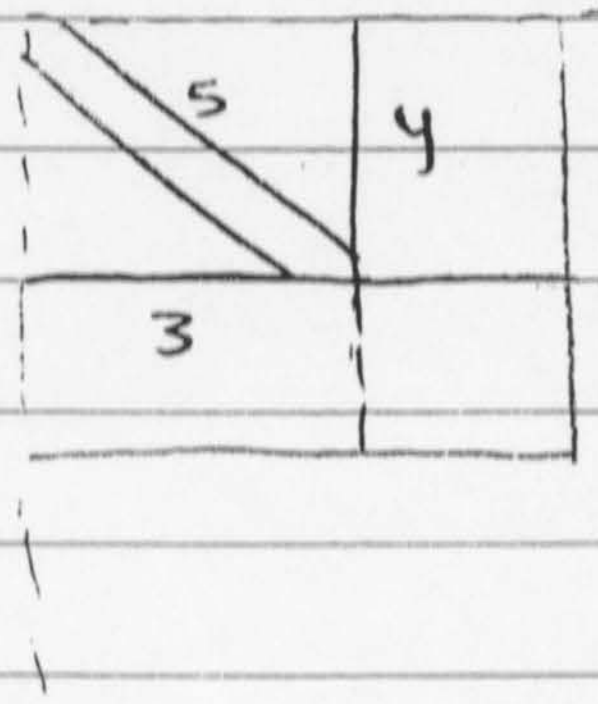
Winner Line

* دائماً ناخذ ال Shear على بعد d من المسند يعني عند الرسم رح نمشي مسافة d من حافة المسند لنجد shear

* عند تحديد ال Shear ولازم نعمل كبيم عريض widebeam فناخذ شريحة بمقدار واحد متر (1.0 m)



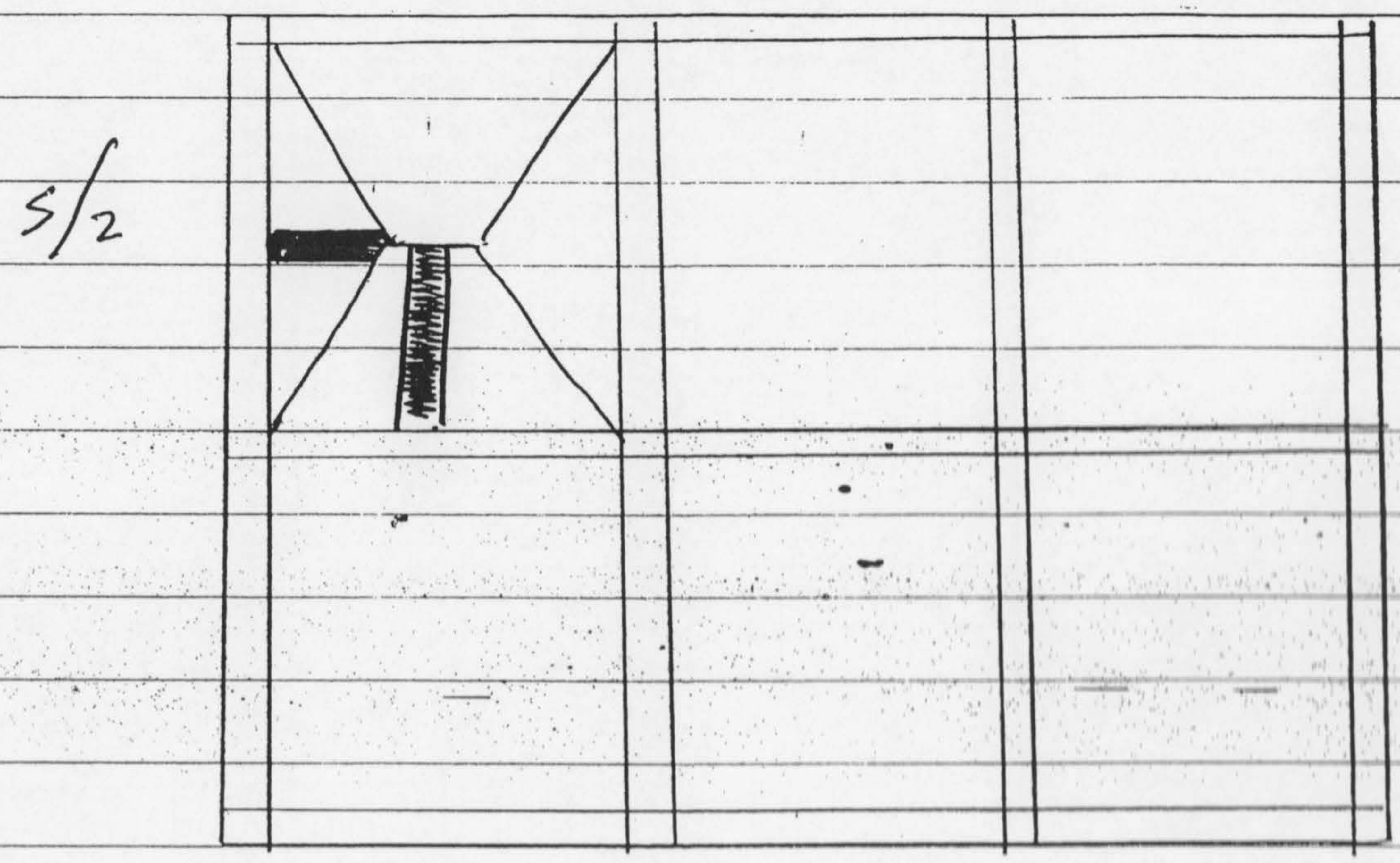
* البيم الموجود بال Corner رح ناخذه شريحة مائلة بزاوية. وناخذ طول افقي و عمودي و باستخدام فيثاغورس نجد طول الشريحة.



$$V_u = (S - d)\, w_u$$

Winner Line

★ عند وجود edge beam نلاحظ أن الشير (shear) ينتقل بشكل مثلث وجزئين شبه منحرف.
حيث ينتقل بشكل مائل بزاوية مقدارها 45°



Slab beam ⟵ هنا ناخذ أطول (S)

Long Short clear
أكبر بعد قصير

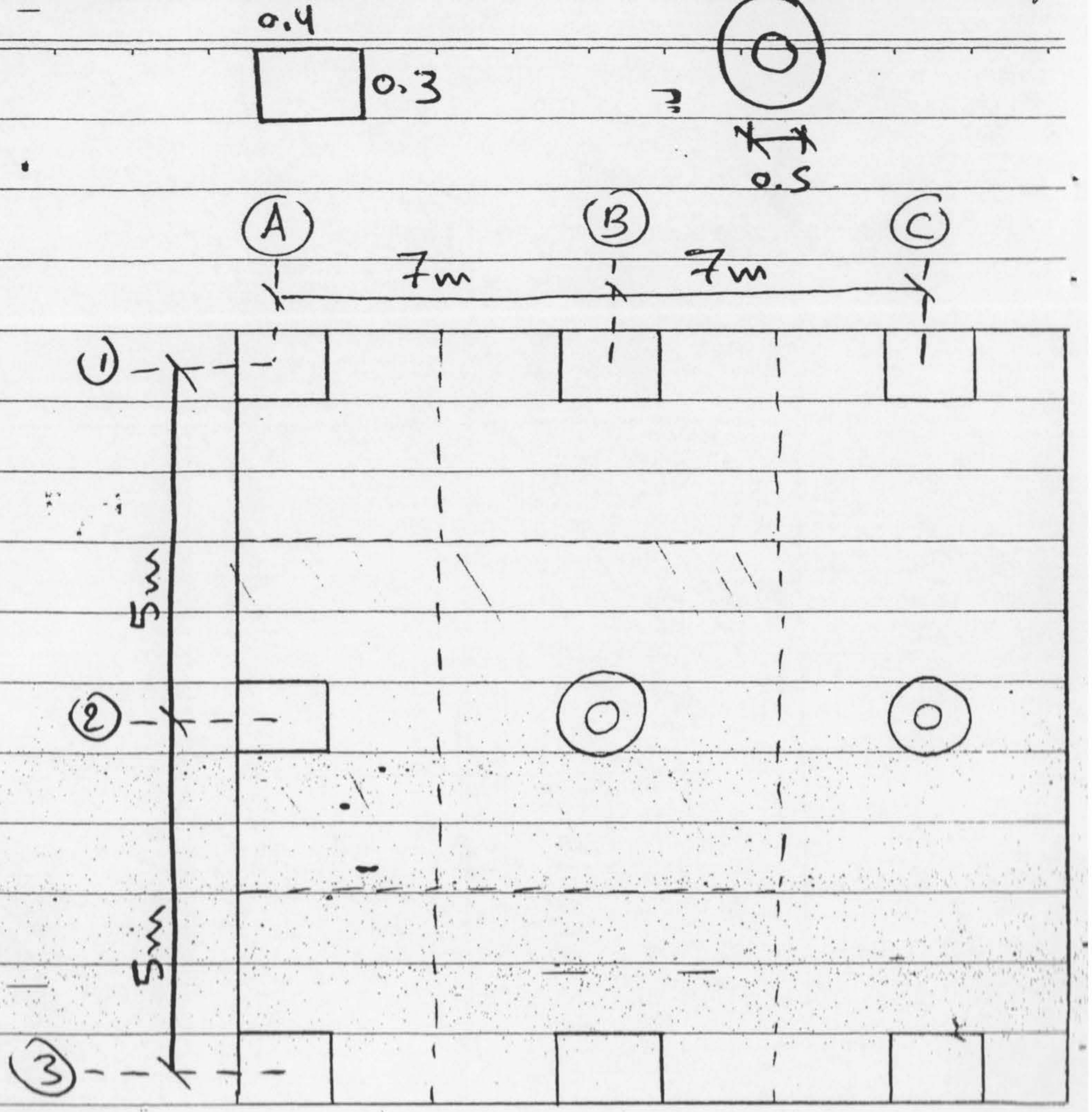
Ex8

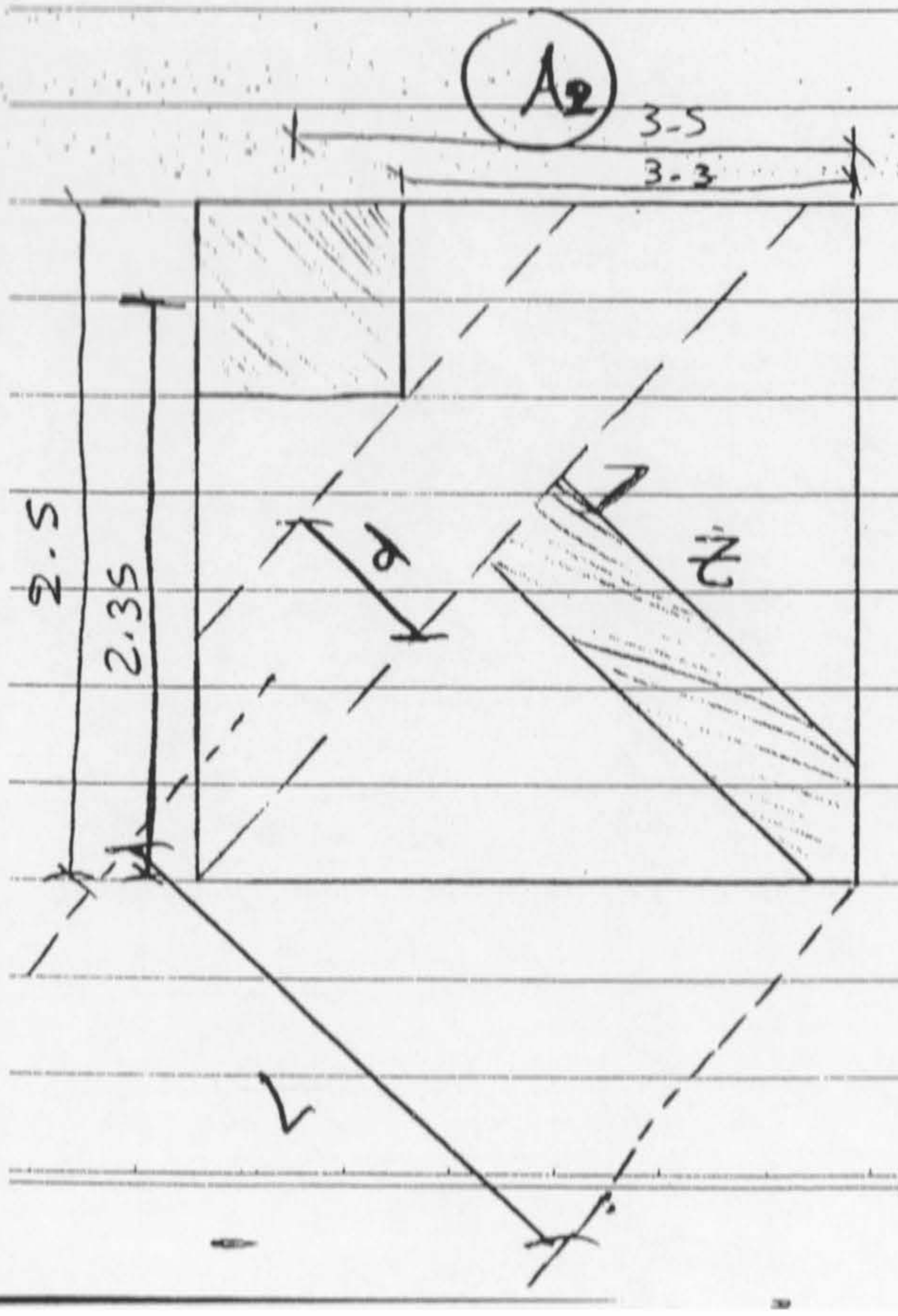
wu = 15 KN/m

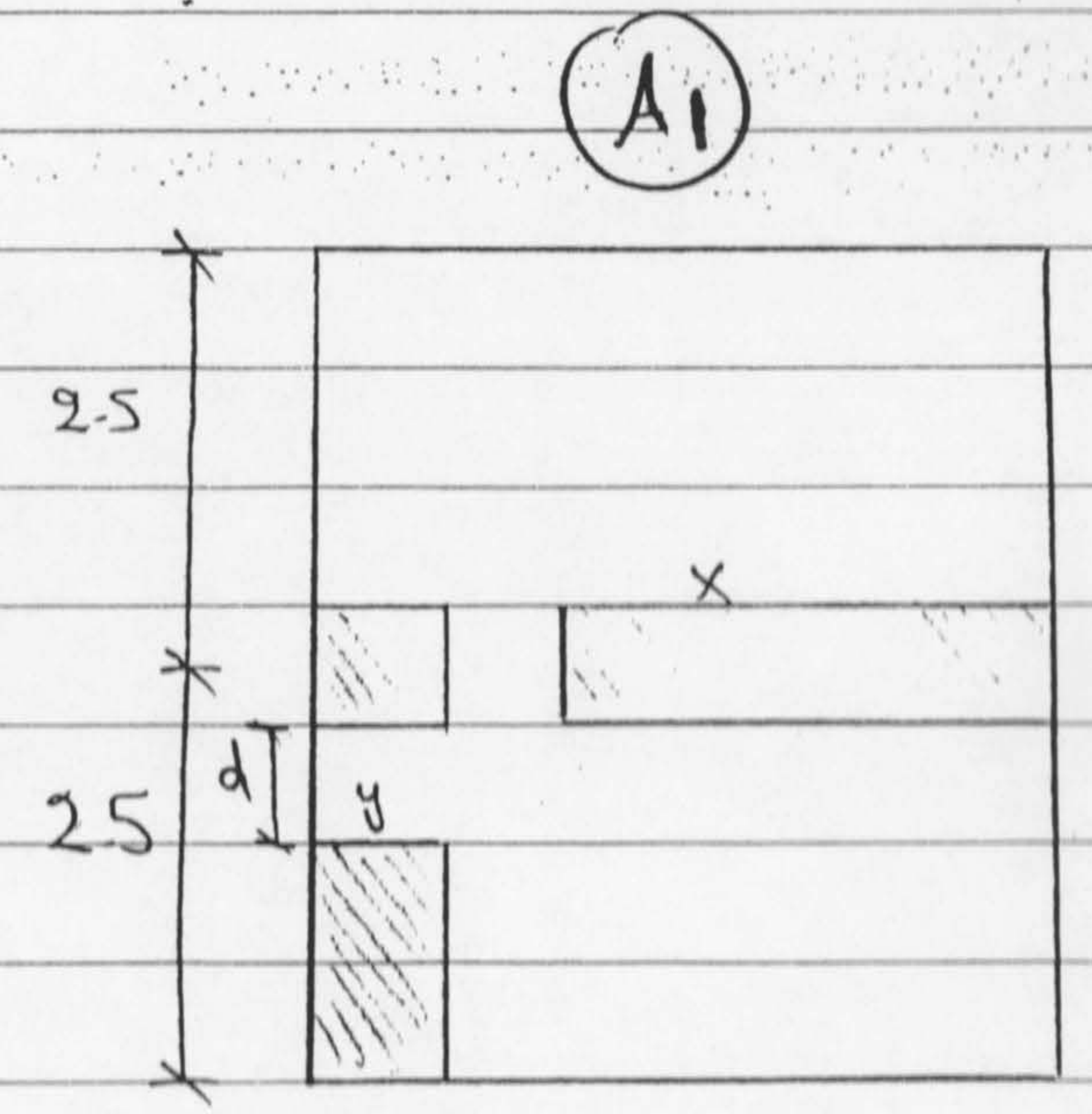
fc = 15 KPa

h = 200 mm

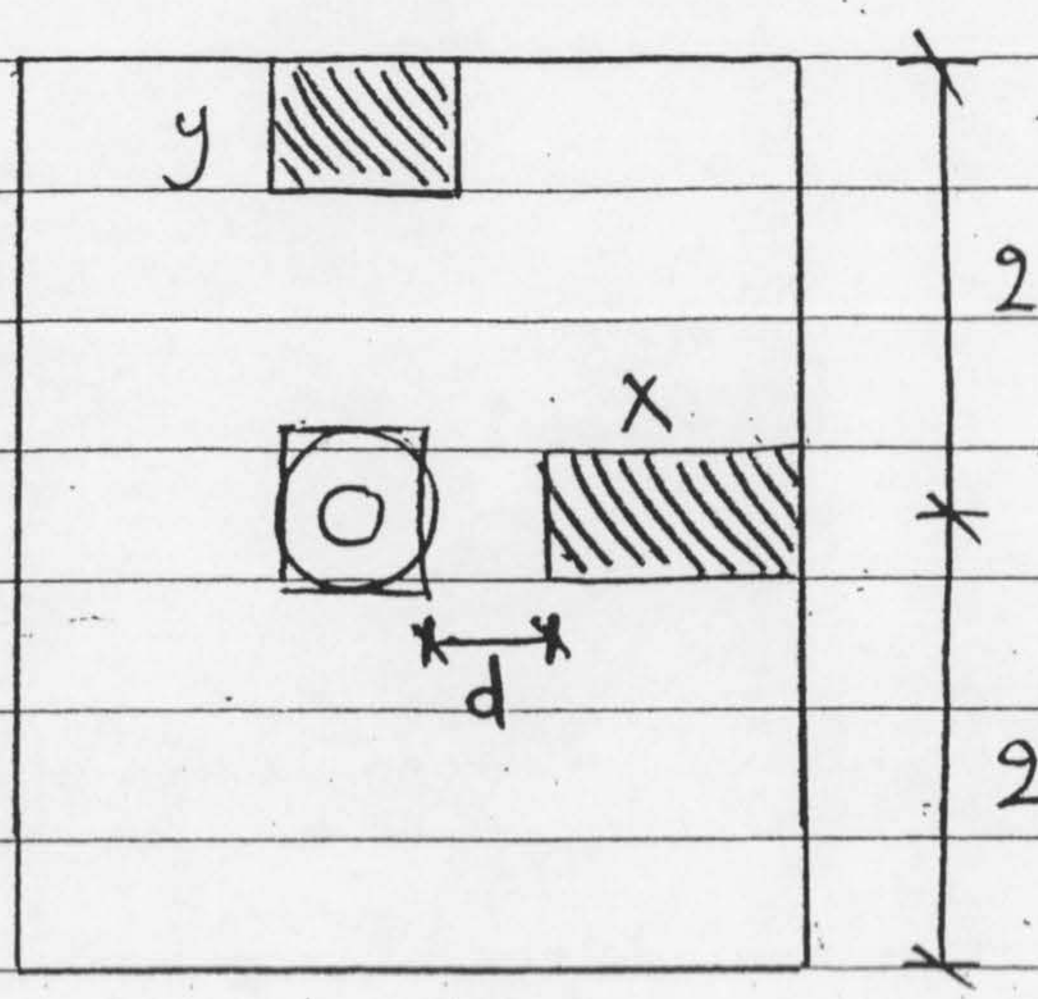
* Check one way shear in slab near column A1 , A2 B2







B2



Sol.

$d = h - 20 - d_b$

$= 200 - 20 - 12 = 168$ mm

A2

$x = 3.5 - \frac{0.4}{2} - 0.168 = 3.132$

$y = 2.5 - \frac{0.3}{2} - 0.168 = 2.18$

نأخذ الأكبر ونكمل في الحل.

$V_u = 15 * 1 * 3.132 = 46.8$ KN

$V_c = 0.17 \sqrt{f_c'}\, b_w d$

$= 0.17 \sqrt{25} * 100 * 168 = 142800$ N

$= 142.8$ KN

$V_u < \phi V_c$

$46.8 < 0.75 * 142.8 = 107$ ∴ OK

(A₂) $L = \sqrt{3.3^2 + 2.35^2} = 4.05$

$Z = 4.05 - 0.1/8 = 3.88$

$V_u = 15 * 1 * 3.88 = 58.2$

$58 < 107$ ∴ OK

نحول الدائرة الى مربع مكافئ

(B₂) $x = 3.5 - \frac{0.89 * 1.5}{2} - 0.168 = 2.66$

$y = 2.5 - \frac{0.89 * 1.5}{2} - 0.168 = 1.69$

$V_u = 15 * 1 * 2.66 = 39.9$

$39.9 < 107$ ∴ OK

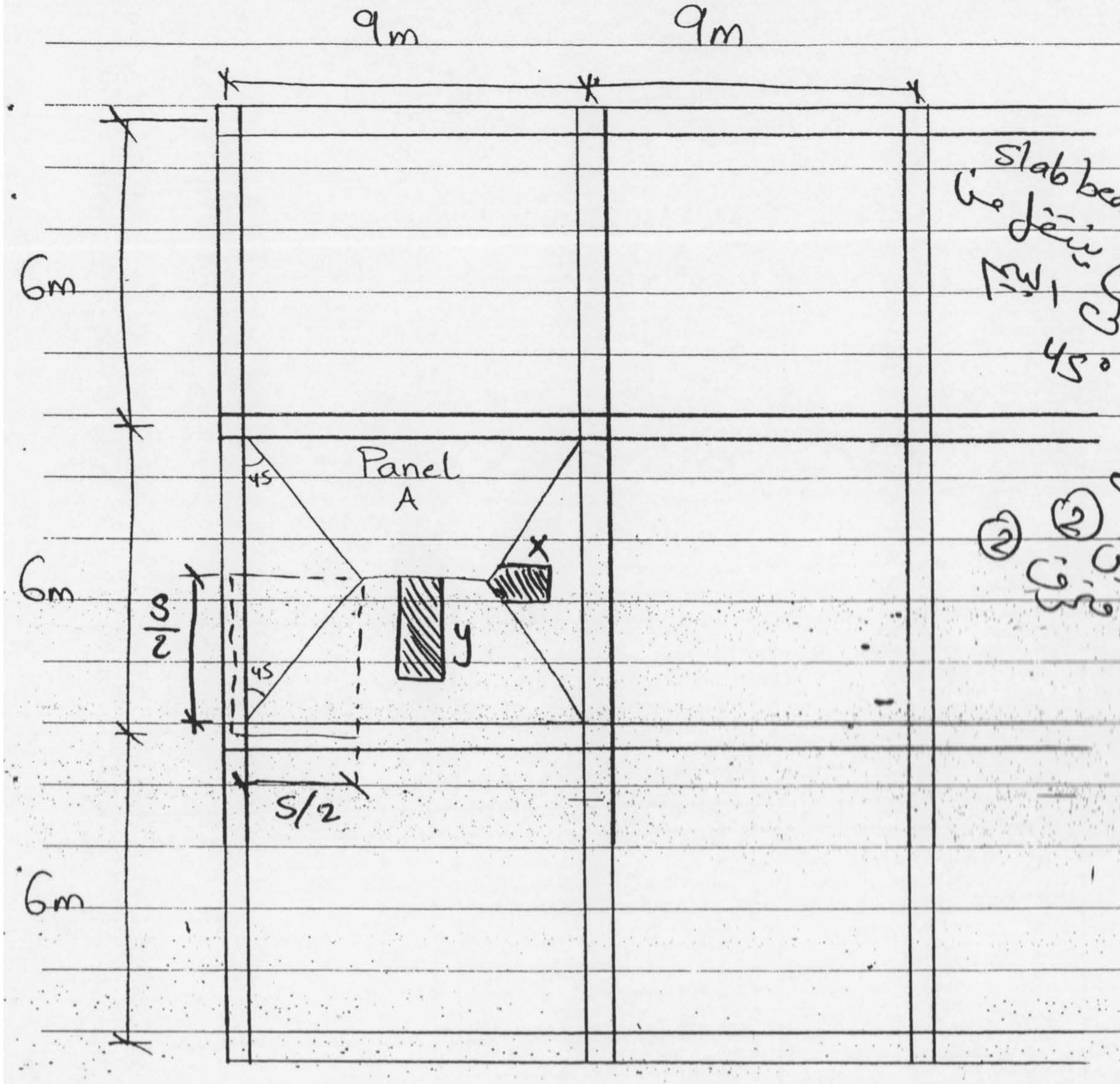
Ex (2) all column 0.4 × 0.4

all beam $0.4 * 0.7$

$f_c = 25$ MPa

$w_u = 15$ KN/m

Cheack Shear at pannel (A)



<u>Sol</u> Column دائماً ننقص من بعد البيم وهنا عندنا ال beam نفس البعد ال

فنا قد (0.4) لو عندنا البيم (0.2)

$x = y = \frac{6}{2} - \frac{0.4}{2} - 0.168 = 2.6$ والكولوم (0.4) اصبح نطرح منه

(0.2) ونقسم على (2)

$V_u = 20 * 2.6 * 1 = 52\ KN$

$V_c = 0.17\sqrt{30} * 1000 * 168 = 156429\ N$
$= 156.429\ KN$

Scanlows

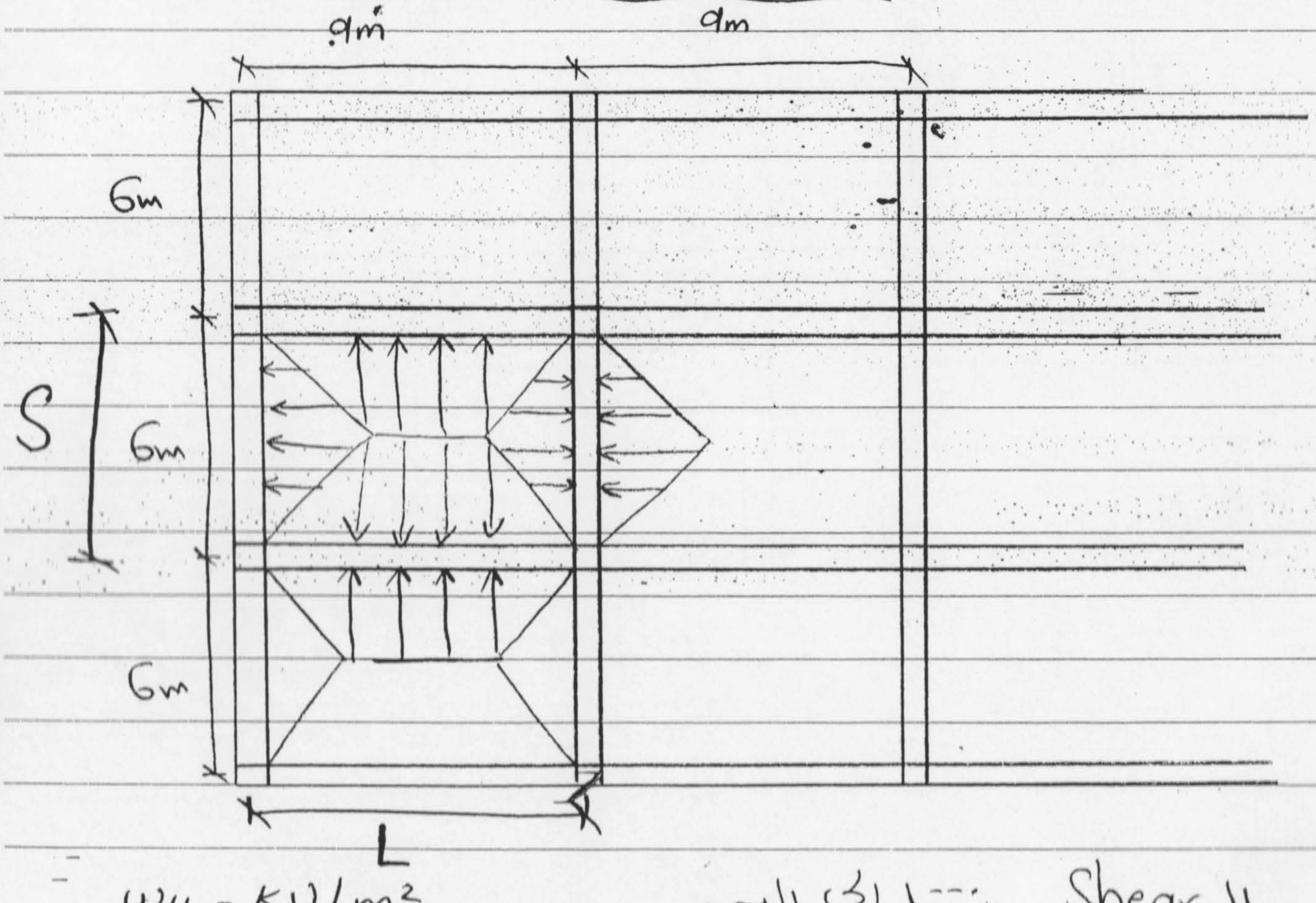
$V_u < \phi V_c$

$52 < 0.75 * 156.429 = 117.3$

$\therefore$ OK

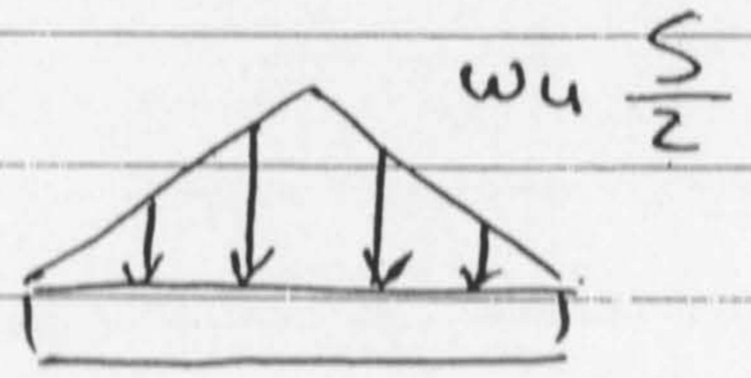
اذا كانت النتيجة not ok
فلازم نرجع نزيد السمك.

Shear in beams :

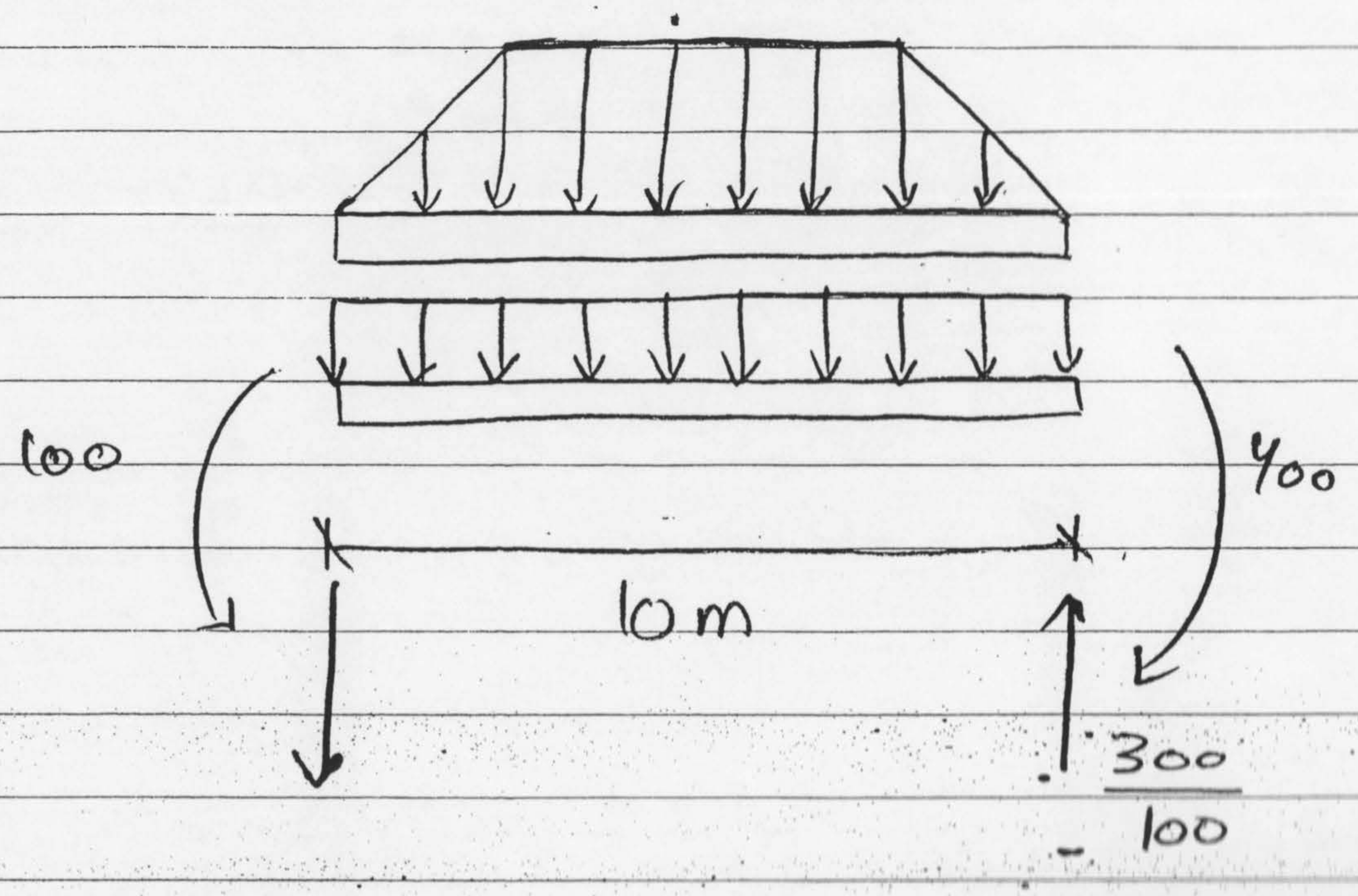


$w_u = kN/m^2$

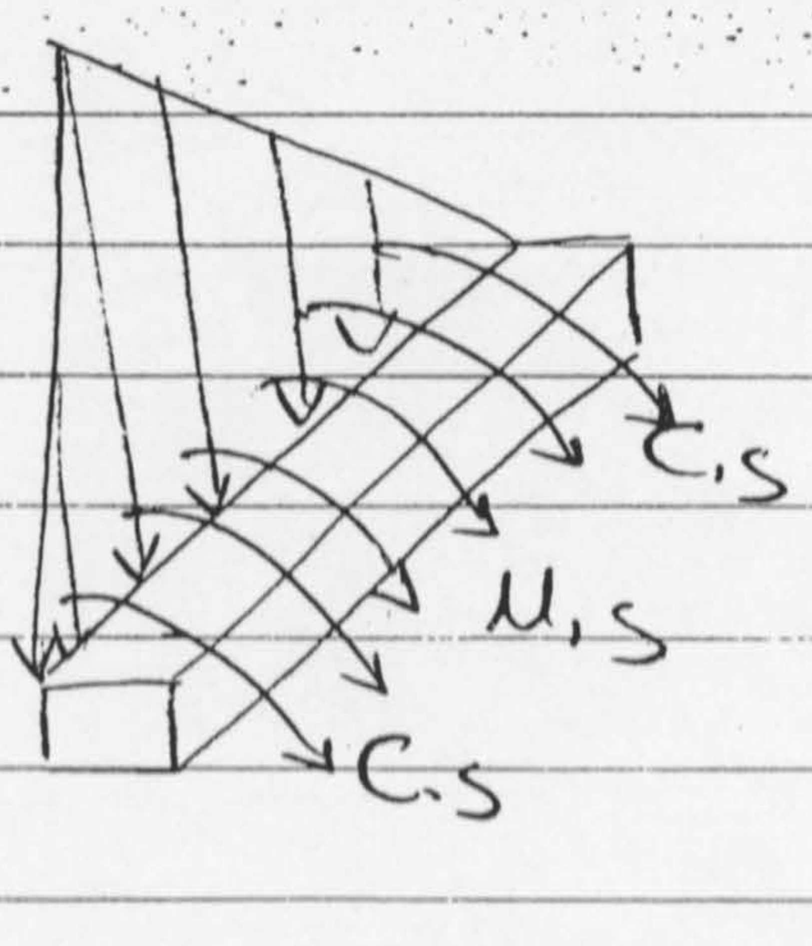
الـ Shear ينتقل الى البيم
من أكثر من جهة.

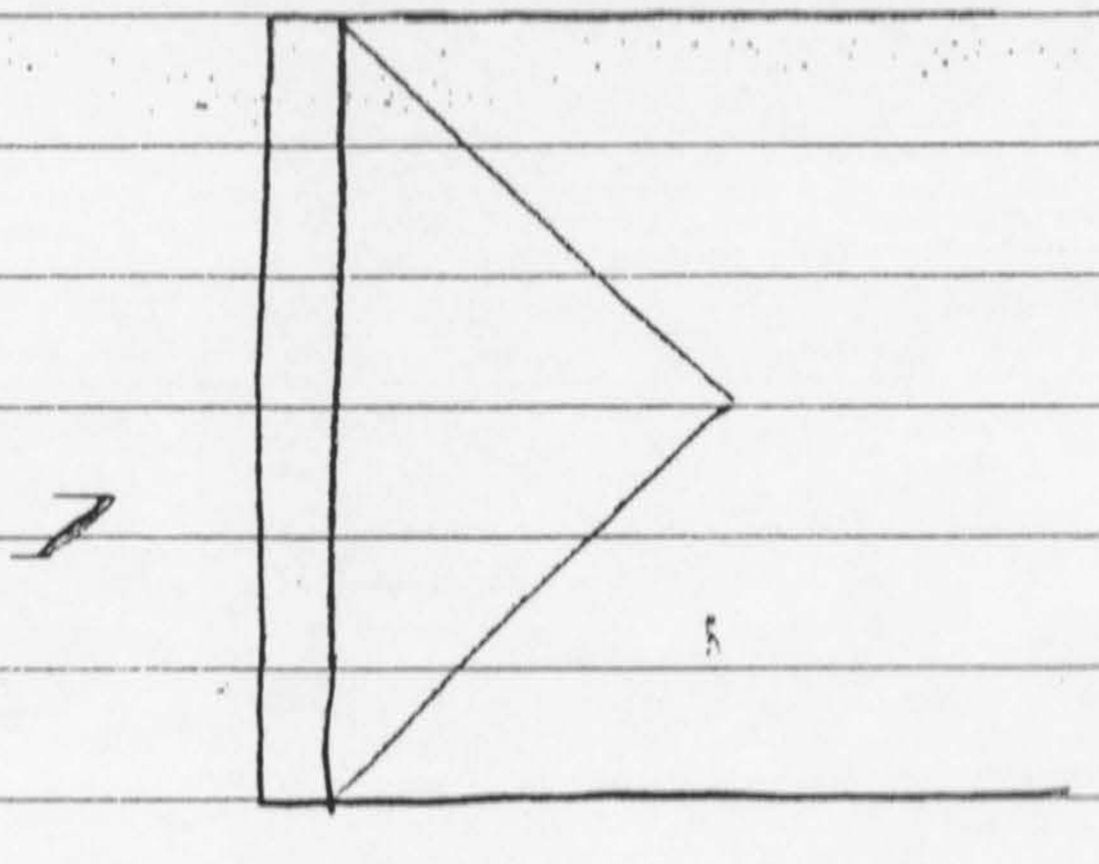


Winner Line

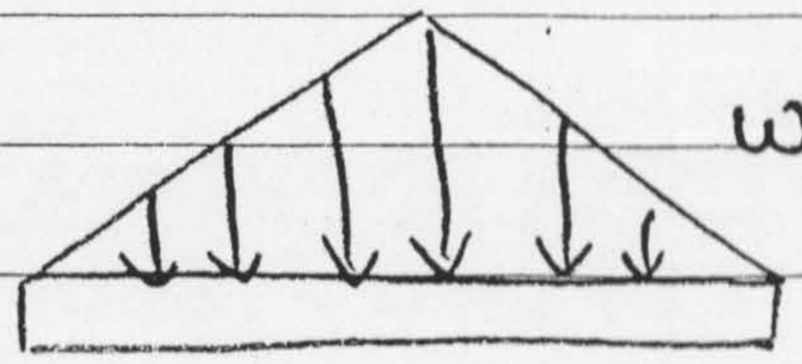


* اذا اخذنا البيم اللي بالحافة اكو مشكلة وجود عزوم
Torsion تسبب C.S و M.S





* اذا كان البيم ضعيف لازم تضرب اللود ب factor



$$w_u = \frac{S}{2} * 2 * \frac{\alpha L_2}{L_1}$$

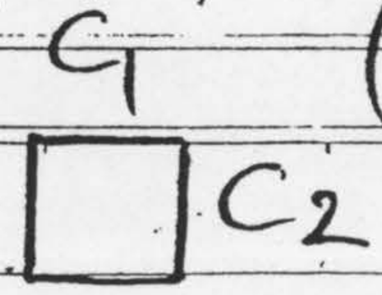
if $\alpha \frac{L_2}{L_1} < 1.0 \Rightarrow$ لازم تشيك ال moment transfer وال Punching Shear

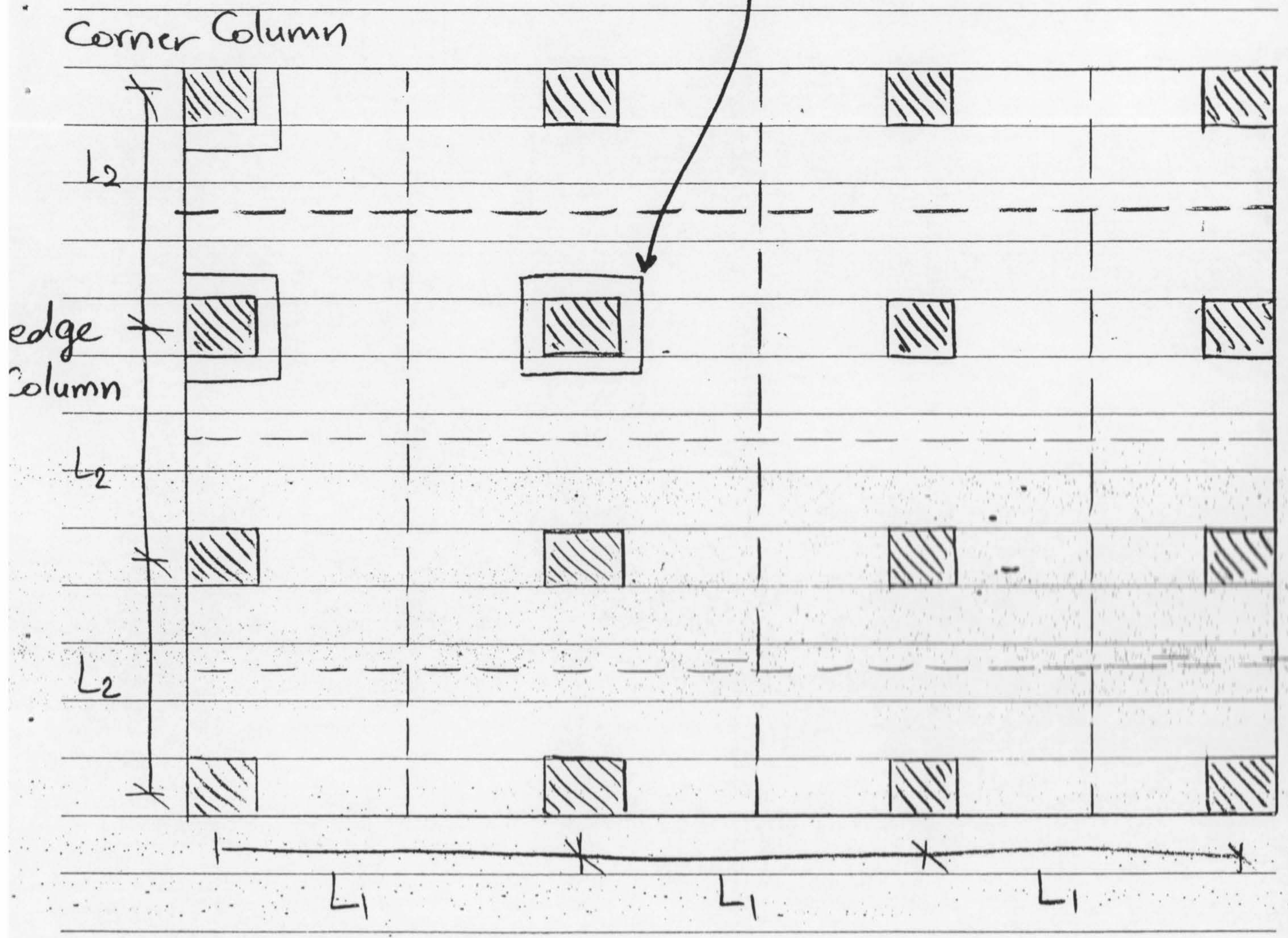
$\alpha \frac{L_2}{L_1} > 1.0 \Rightarrow$ مافي داعي تشييك.

الموضوع : التاريخ / / ٢٠

12/1/2016

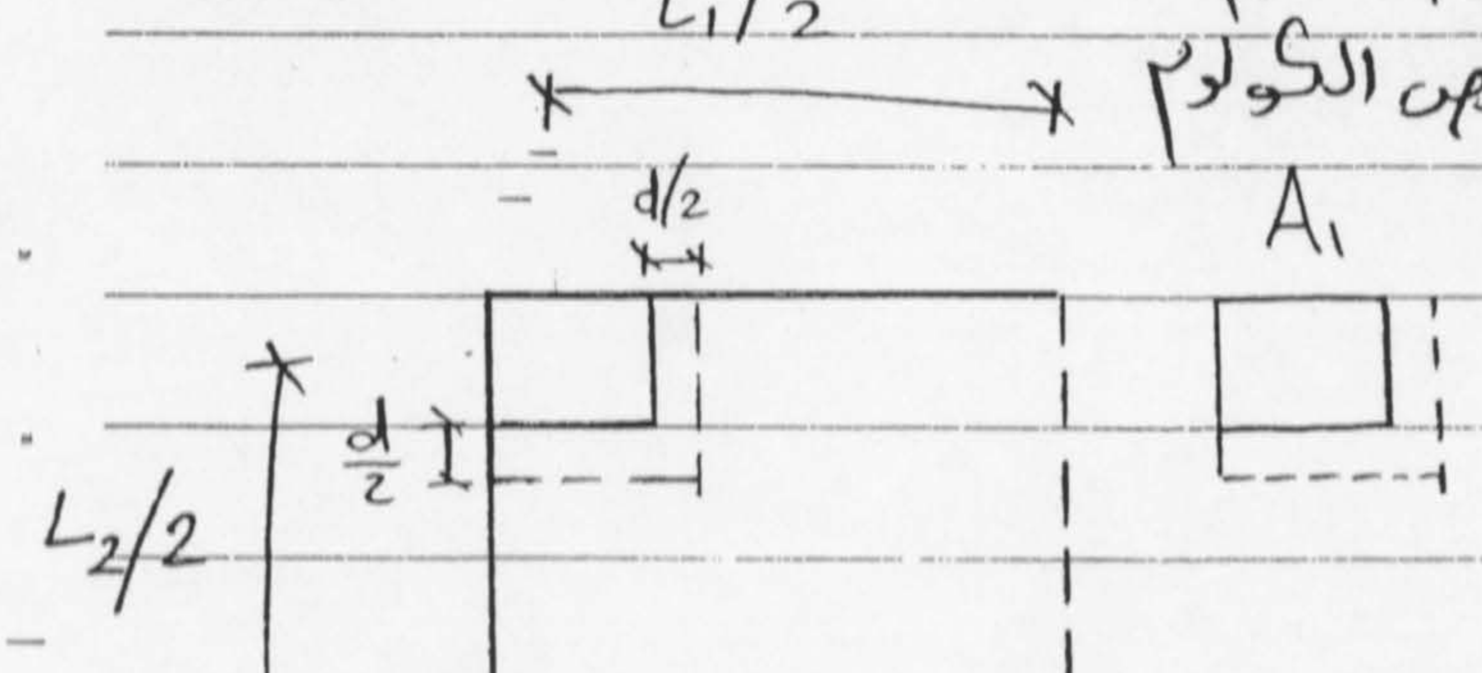
(Two-way Shear (Punching shear))





Corner Column

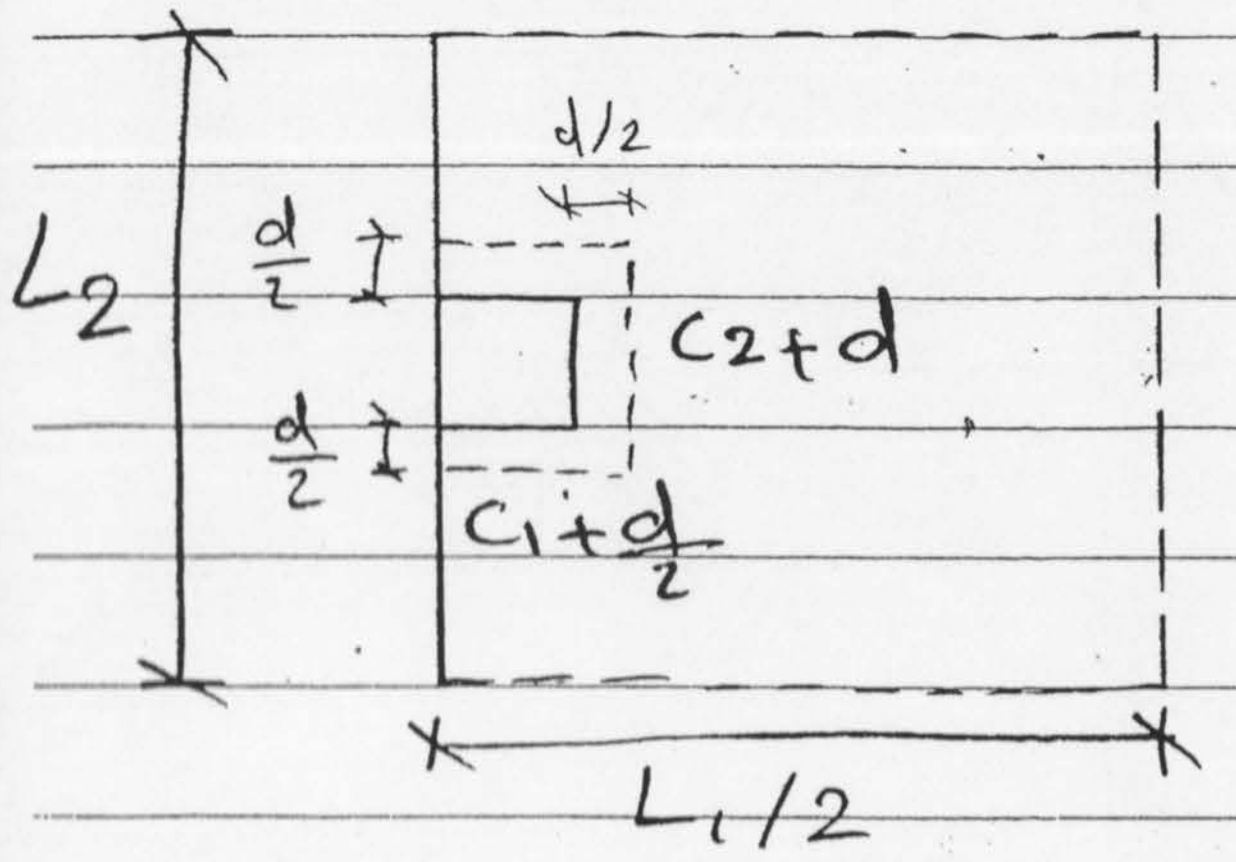
(مساحة الشكل كله) ← عند البعاد c/c لازم نضيف نص الكولوم



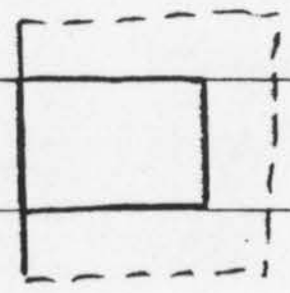
$$V_u = w_u\left[\text{total area} - A_1\right]$$

$$= w_u\left[\left(\frac{L_1}{2}+\frac{C_1}{2}\right)\left(\frac{L_2}{2}+\frac{C_2}{2}\right) - \left(C_1+\frac{d}{2}\right)\left(C_2+\frac{d}{2}\right)\right]$$

edge Column



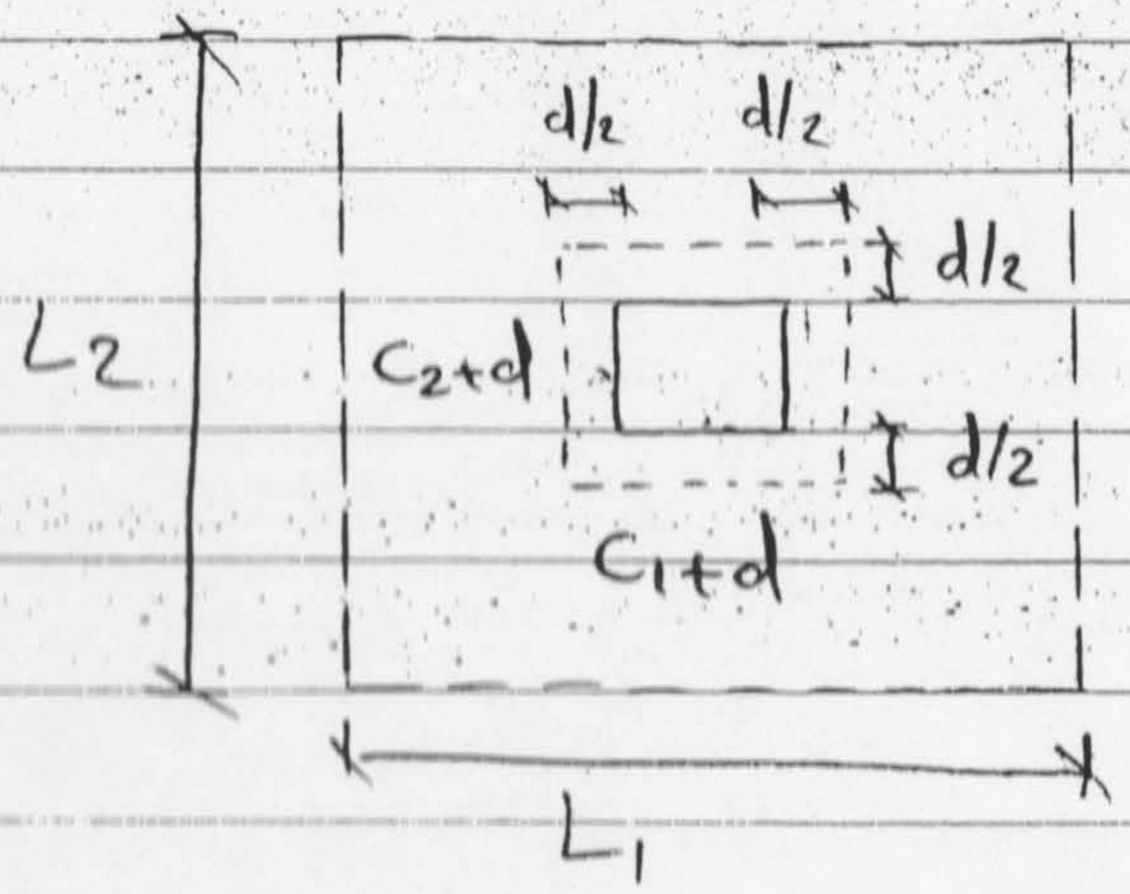
A1



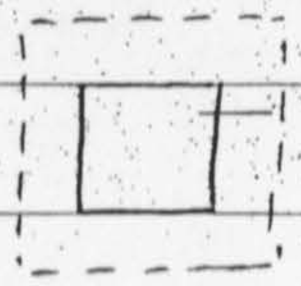
$$V_u = [\text{total area} - A_1]\, w_u$$

$$= w_u\left[L_2 * \left(\frac{L_2}{2} + \frac{c_1}{2}\right) - (c_2+d)\left(c_1+\frac{d}{2}\right)\right]$$

interior Column



A1



$$V_u = w_u[\text{total area} - A_1]$$

$$= w_u\left[L_1 \times L_2 - (c_1+d)(c_2+d)\right]$$

حساب الـ Vc الـ Concret نحتاج الى ٣ معادلات وناخذ القيمة الاقل .

$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{\beta}\right)\sqrt{f_c}\, b_o d \\ 0.083\left(\frac{\alpha_s d}{b_o}\right)\sqrt{f_c}\, b_o d \\ 0.33\sqrt{f_c}\, b_o d \end{cases}$$

b_o محيط الفشل

Corner / $b_o = \left(C_1 + \frac{d}{2}\right) + \left(C_2 + \frac{d}{2}\right)$

edge / $b_o = (C_1 + d) + (C_2 + d) * 2$

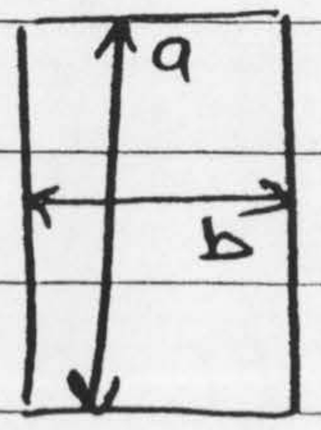
interior / $b_o = \left[(C_1 + d) + (C_1 + d)\right] * 2$

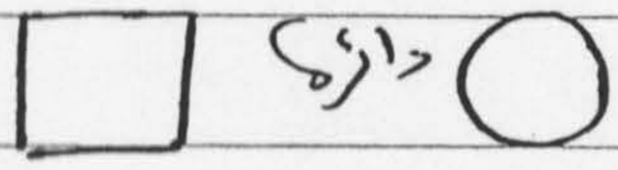
d average اخذ الـ

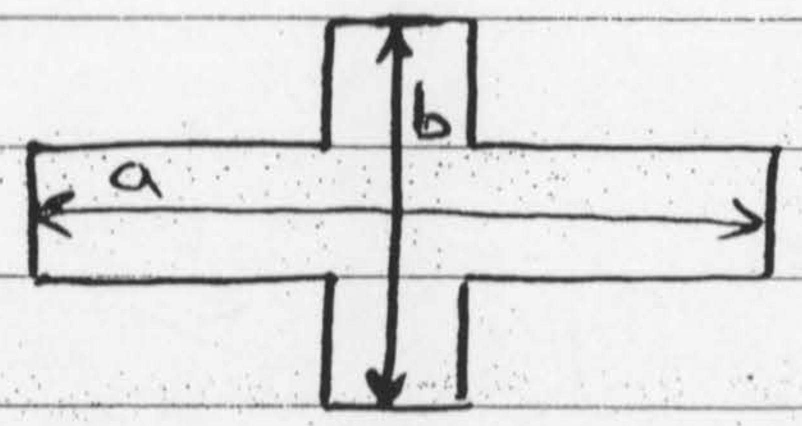
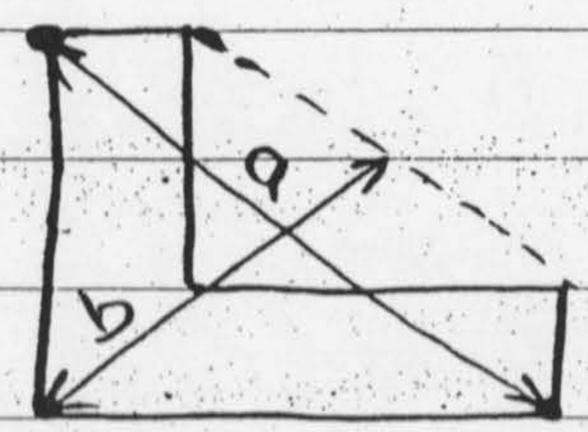
$d = h - 20 - d_b$ — اما يعطى او ناخذه من هذه المعادلة

β

$\beta = \frac{\text{Long side of Column}}{\text{Short side of Column}}$ — $\frac{\text{اكبر بعد}}{\text{اصغر بعد}}$

مستطيل  $\beta = \frac{a}{B}$

مربع  دائرة $\beta = 1$

ناخد اكبر مسافة بين نقطتين ونحدد a ونرسم خط وهمي بين الكافتين وعمودي عليه هو ال b

α_s

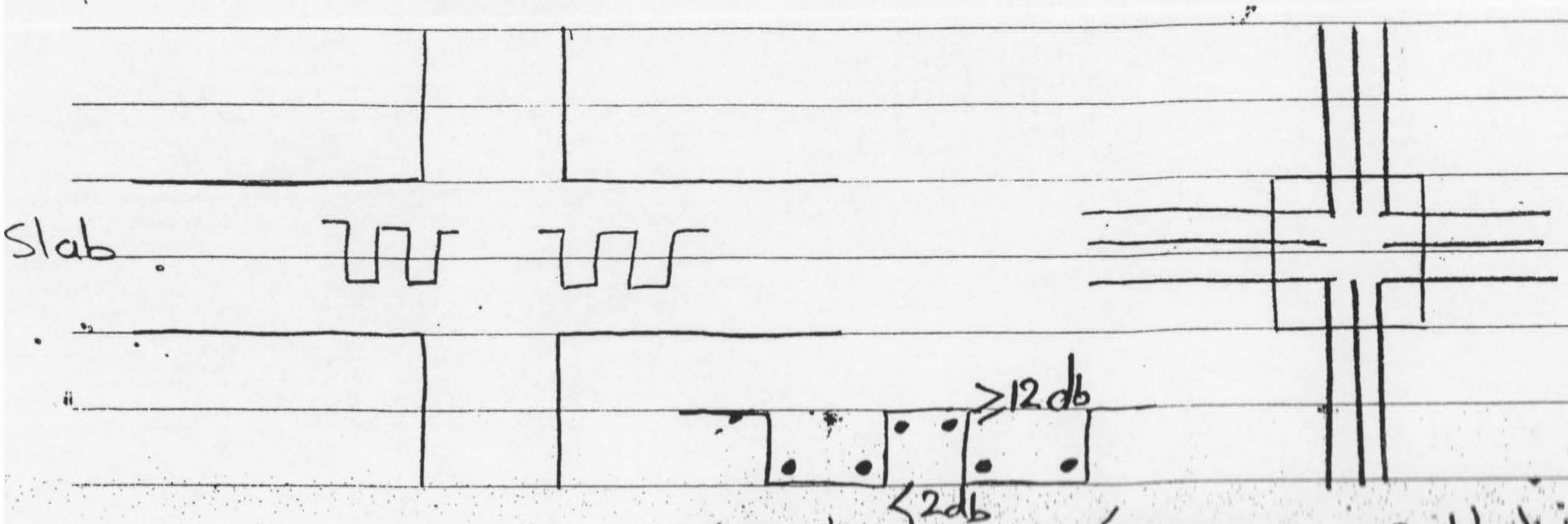
$\alpha_s = 40$ interior
$= 30$ Edge
$= 20$ Corner

note الـ Vc منقارن بيه وهدي لازم نضربه بـ factor

if $V_u \leq \phi V_c$ ∴ OK
if $V_u > \phi V_c$ → increase d
→ use drop pannel
→ use Column Capital
→ use drop pannel + Column capital
→ increase Size of Column
→ OR Use Rienforcement

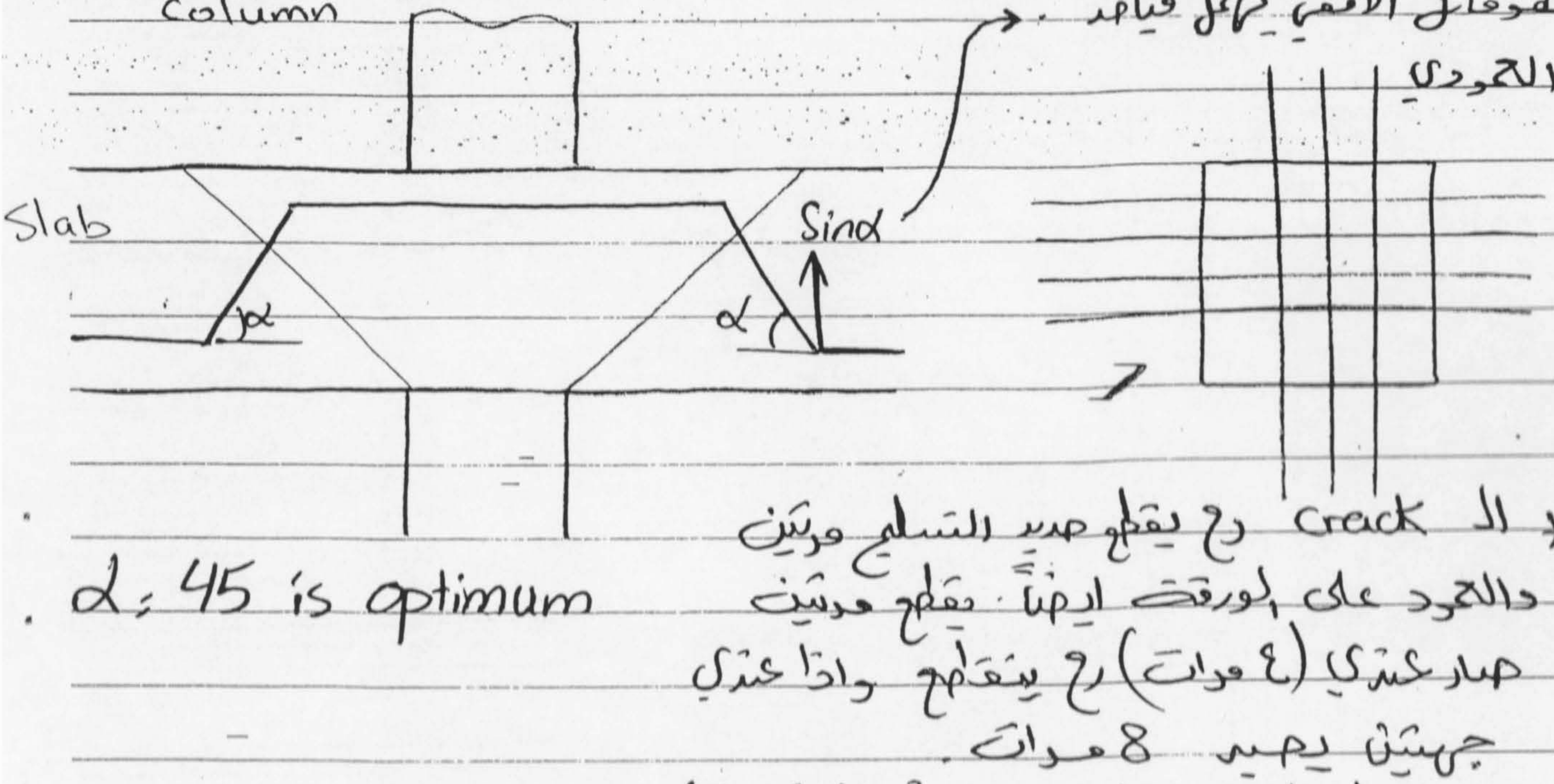
أساليب التسليح

① Vertical Rienforcement, (Double U).



اذا طلعت المسافة اكبر من d رح يقطع مرة وحدة واذا طلعت المسافة اصغر من d رح يقطع مرتين.

② Bent bars

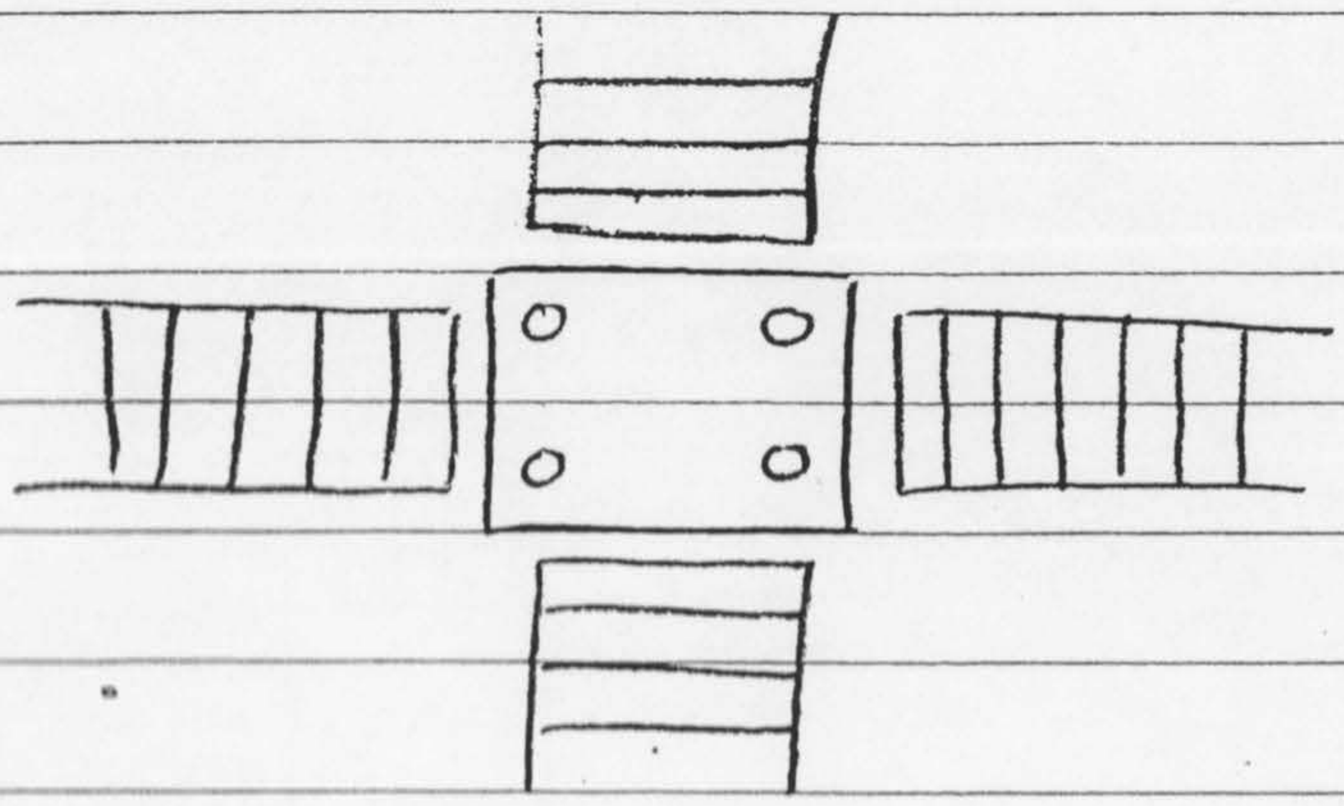


α ; 45 is optimum

* الـ crack رح يقطع حديد التسليح مرتين والعمود على الورقة ايضا يقطع مرتين صار عندي (٤ مرات) رح يتقاطع واذا عندي جهتين يصير 8 مرات.
* هذا التسليح لا يفضل في الموقع لأن صعب التنفيذ.

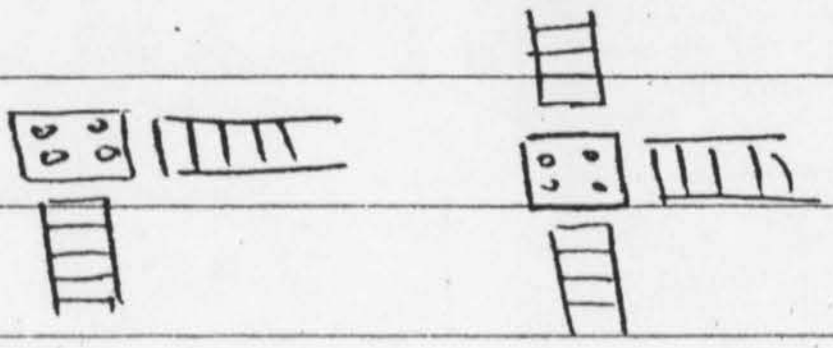
③ web Rienforcement (interior beam)

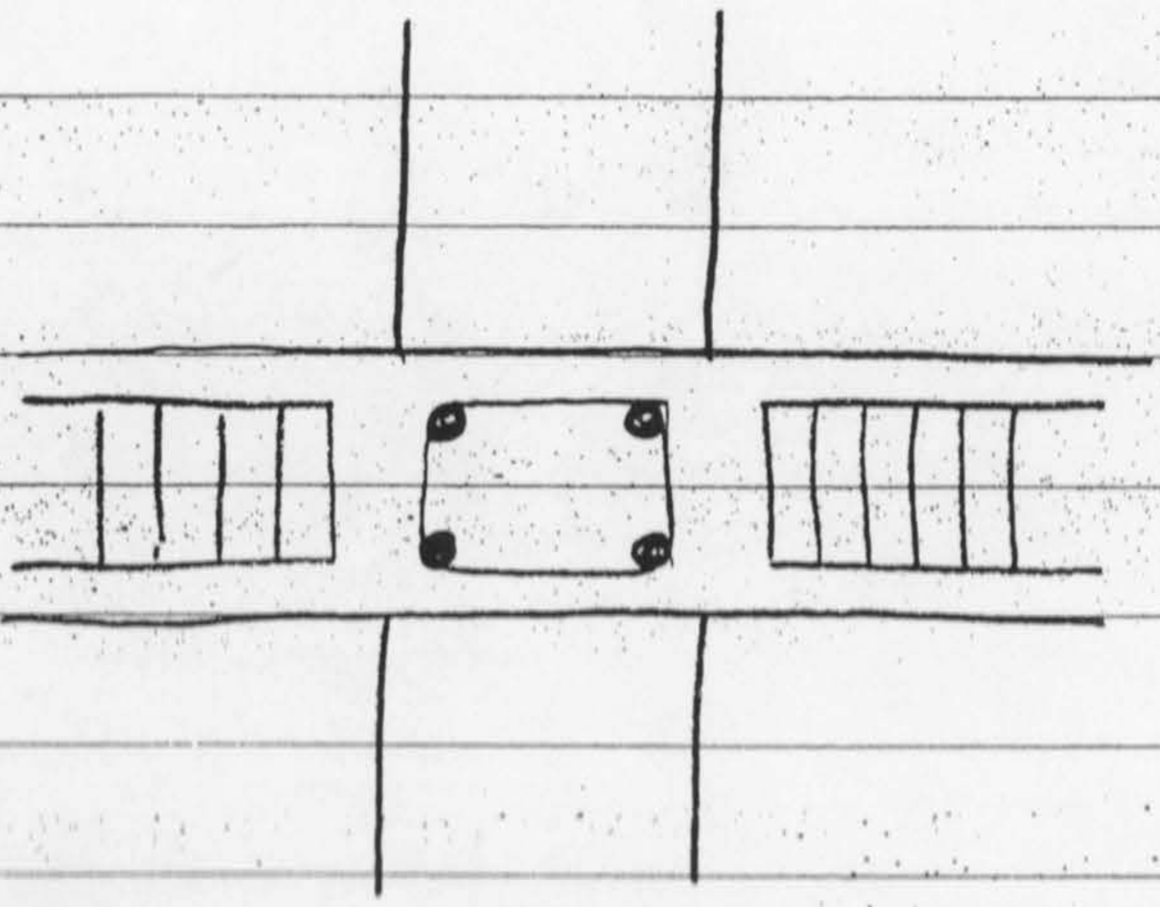
هذا التسليح هو افضل انواع التسليح.



هذا التسليح للinterior ←

لازم ننتبه للedge والCorner

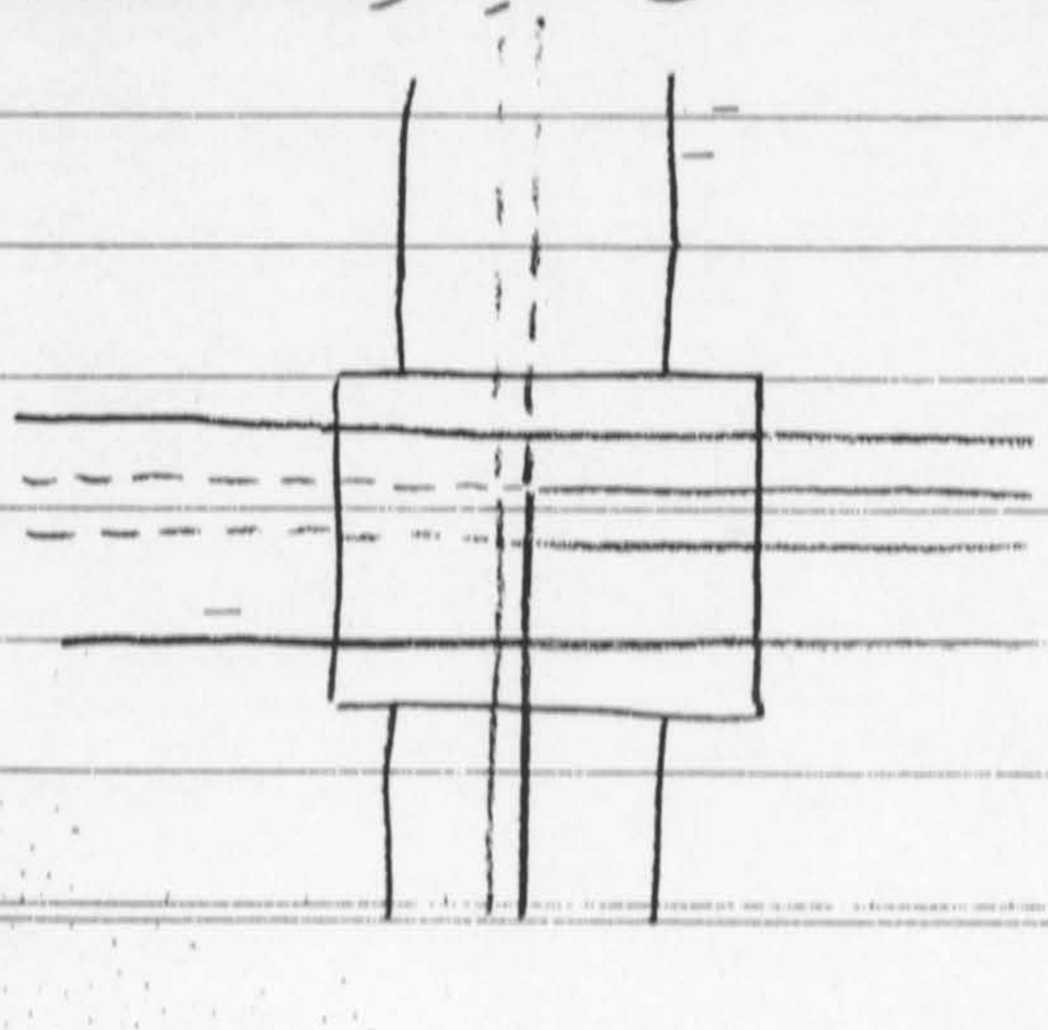


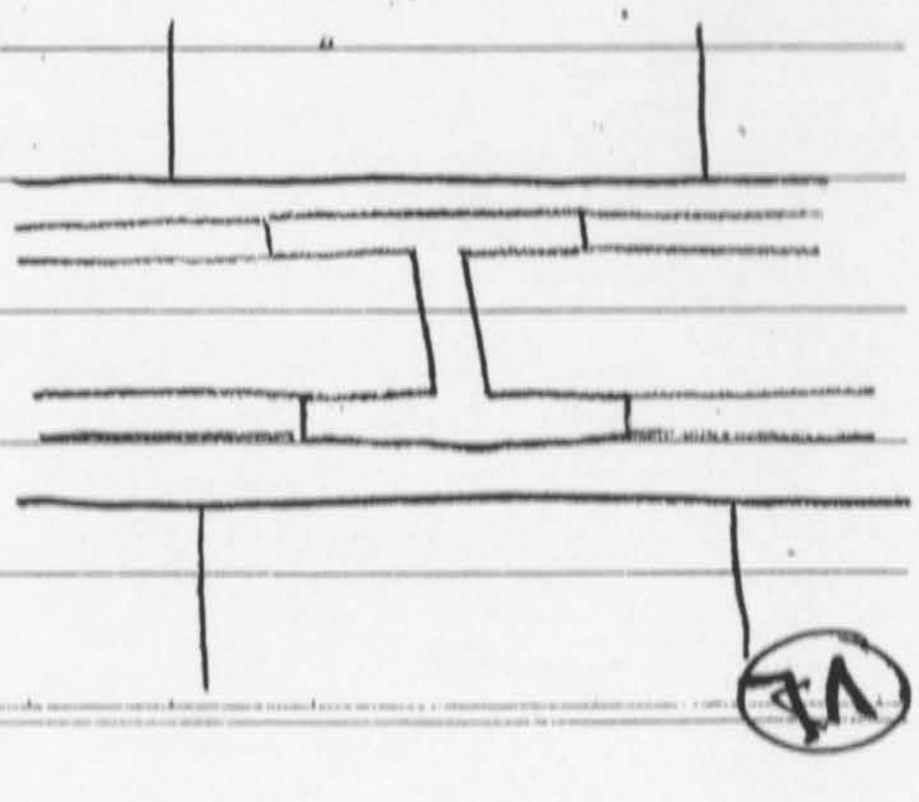


④ Shear head Reinforcement

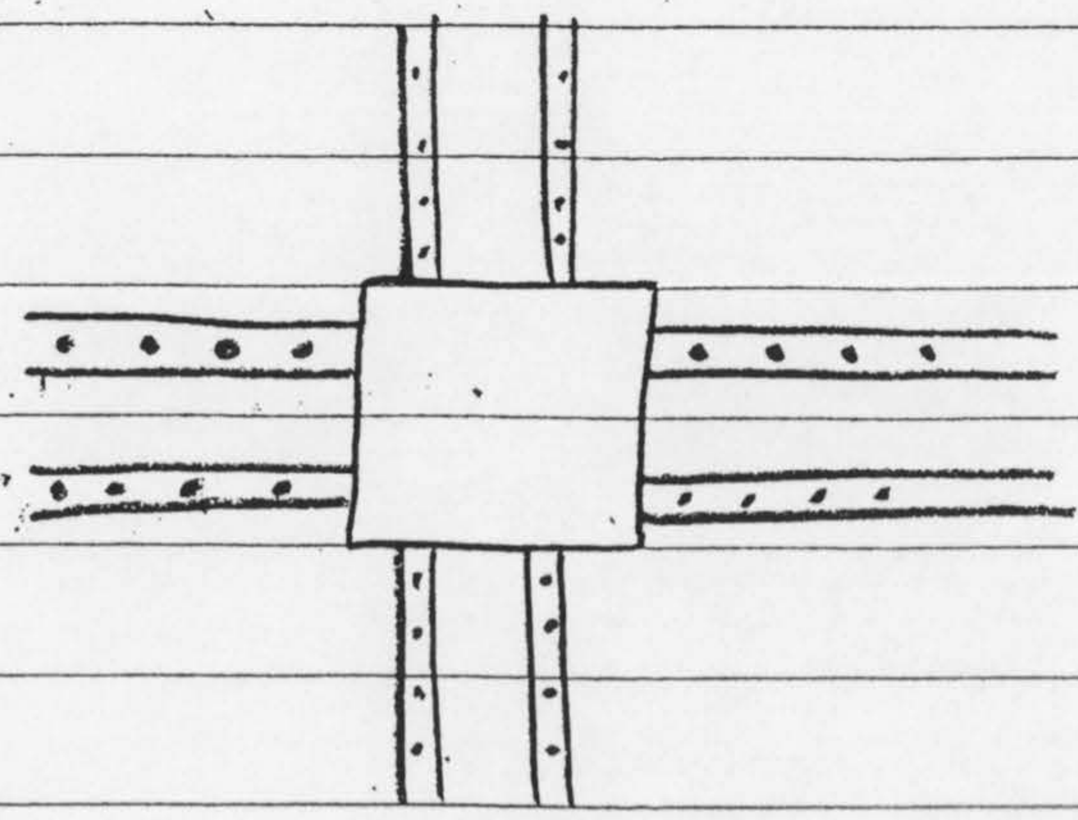
أحياناً بدل استخدام التسليح بوضع بدل البيم (I_Section) بشكل صليب.

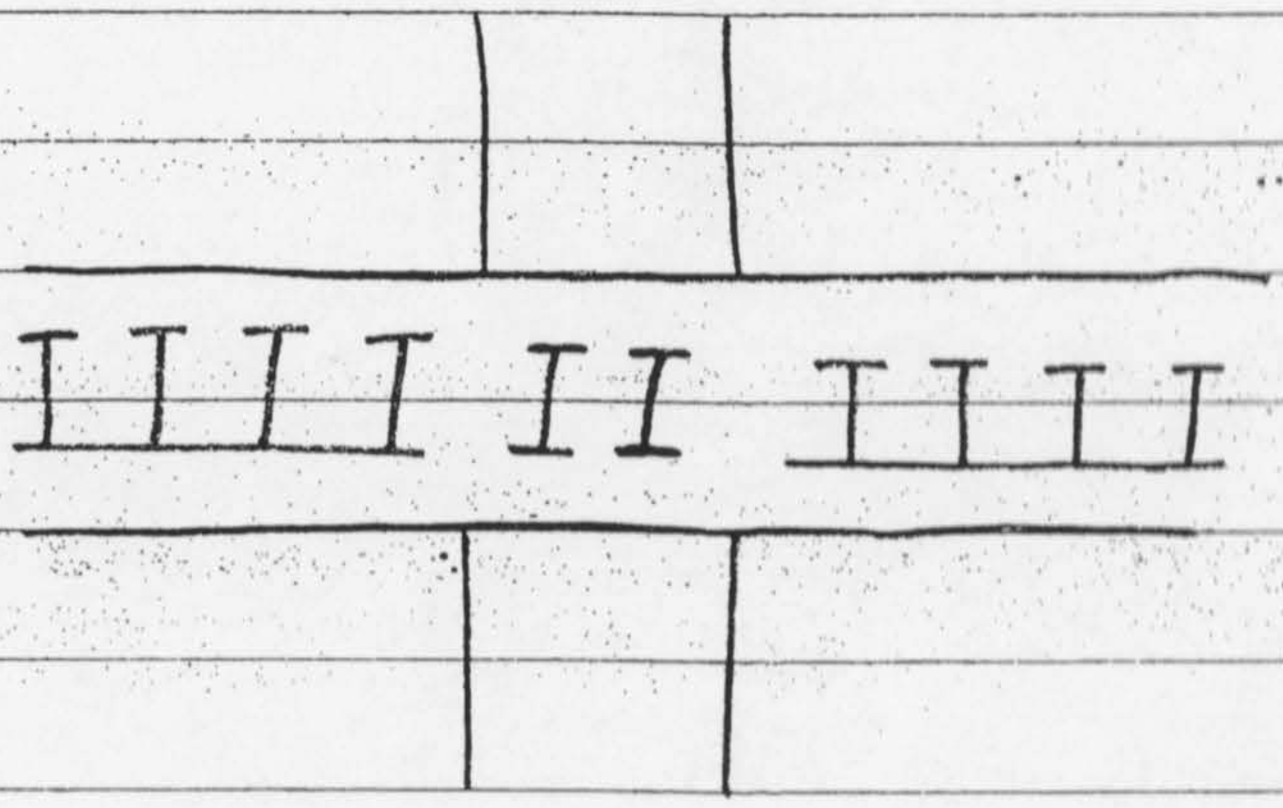
يستخدم هذا النوع عندما يكون الColumn من حديد والSlab من كونكريت





(5) Shear Conector





(A) $V_u < \phi V_c$ no need for Reinforcement

(B) $V_u > \phi V_c$

$$V_n = V_c + V_s$$
$$V_u = \phi V_c + \phi V_c$$
$$\phi V_s = V_u - \phi V_c$$

$$V_s = \frac{V_u - \phi V_c}{\phi}$$

$$F_y A_v = \frac{V_u - \phi V_s}{\phi}$$

$$A_v = \frac{V_u - \phi V_c}{\phi f_y}$$

$$V_c = 0.17 \sqrt{f_c}\, b_o d$$

$$\sin\alpha \, A_v f_y = \frac{V_u - \phi V_c}{\phi}$$ تاخذ المركبه العموديه

$$A_v = \frac{V_u - \phi V_c}{\sin\alpha \, \phi \, A_v}$$

ال bent لازم أعمل شغلتين

<u>note</u> ① if $V_u > \phi\, 0.5 \sqrt{f_c}\, b_o d$
increase in depth of slab

② $V_s = \frac{V_u - \phi V_c}{\phi} \leq 0.25 \sqrt{f_c}\, b_o d$

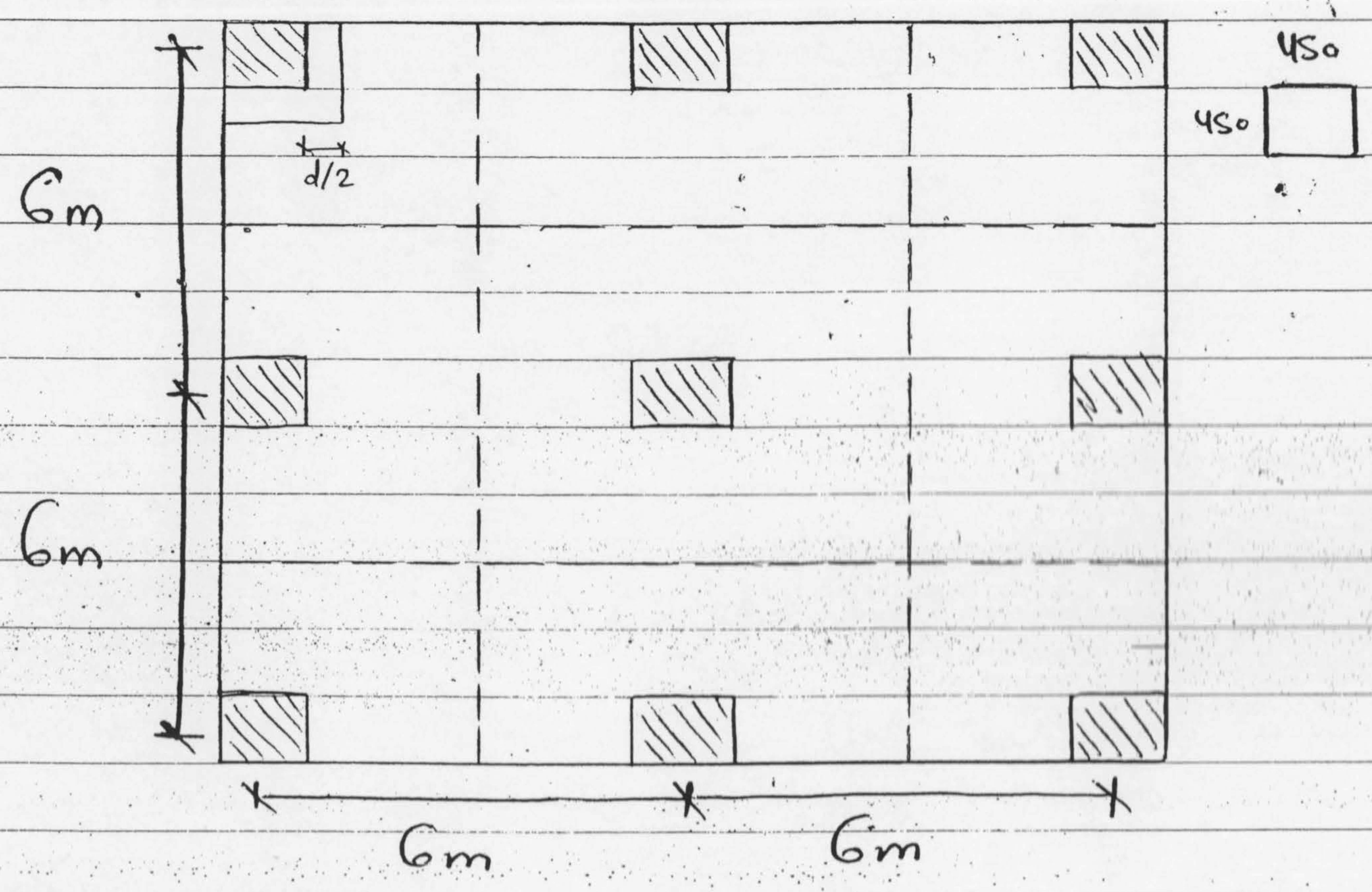
$$A_v = \frac{V_s * S}{F_y \cdot d}$$ ⟹ في حالة ال web Reinforcement

14/1/2016

الموضوع :	التاريخ : / / ٢٠

Ex Check the punching shear around the corner, edge and interior.

$w_u = 8\ kN/m^2$, $f_c = 28$, $f_y = 420$, $d = 150\ mm$



Corner Column

$V_u = W_u[\text{total Area} - A_1]$

$= 8[(3+0.225)(3+0.225) - (0.45+0.071)(0.45+0.075)]$

$= 81\ kN$

$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{\beta}\right)\sqrt{f_c}\, b_o d \\ 0.083\left(2+\frac{\alpha_s d}{b_o}\right)\sqrt{f_c}\, b_o d \\ 0.33\sqrt{f_c}\, b_o d \end{cases}$$

$b_o = 450 + 75 + 450 + 75 = 1050$

$\beta = \frac{450}{450} = 1$

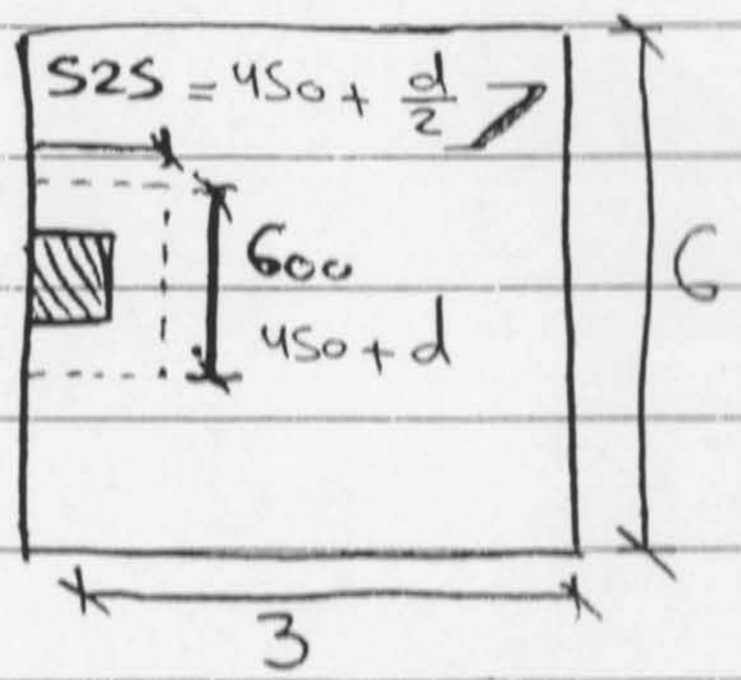
$\alpha_s = 20$ (Corner)

$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{1}\right)\sqrt{25} * 1050 * 150 * 10^{-3} = 425.039 \\ 0.083\left(2+\frac{20*15}{1050}\right)\sqrt{28} * 1050 * 150 * 10^{-3} = 560.772 \\ 0.33\sqrt{28} * 1050 * 150 * 10^{-3} = 275.02 \end{cases}$$

$\therefore V_c = 275.02$ KN

$V_u \leq \phi V_c$

$81 \leq 0.75 * 275.02 = 206.269$ $\therefore$ OK



Edge Column

$V_u = w_u$ [total area by ℄ − A_1]

$= 8\left[6 * \left(3 + \frac{0.45}{2}\right) - (0.6 * 0.525)\right] = 152.28$ KN

Winner Line

$b_o = 600 + 525 * 2 = 1650$

$\beta = 450/450 = 1$

$\alpha_s = 30$ (edge col.)

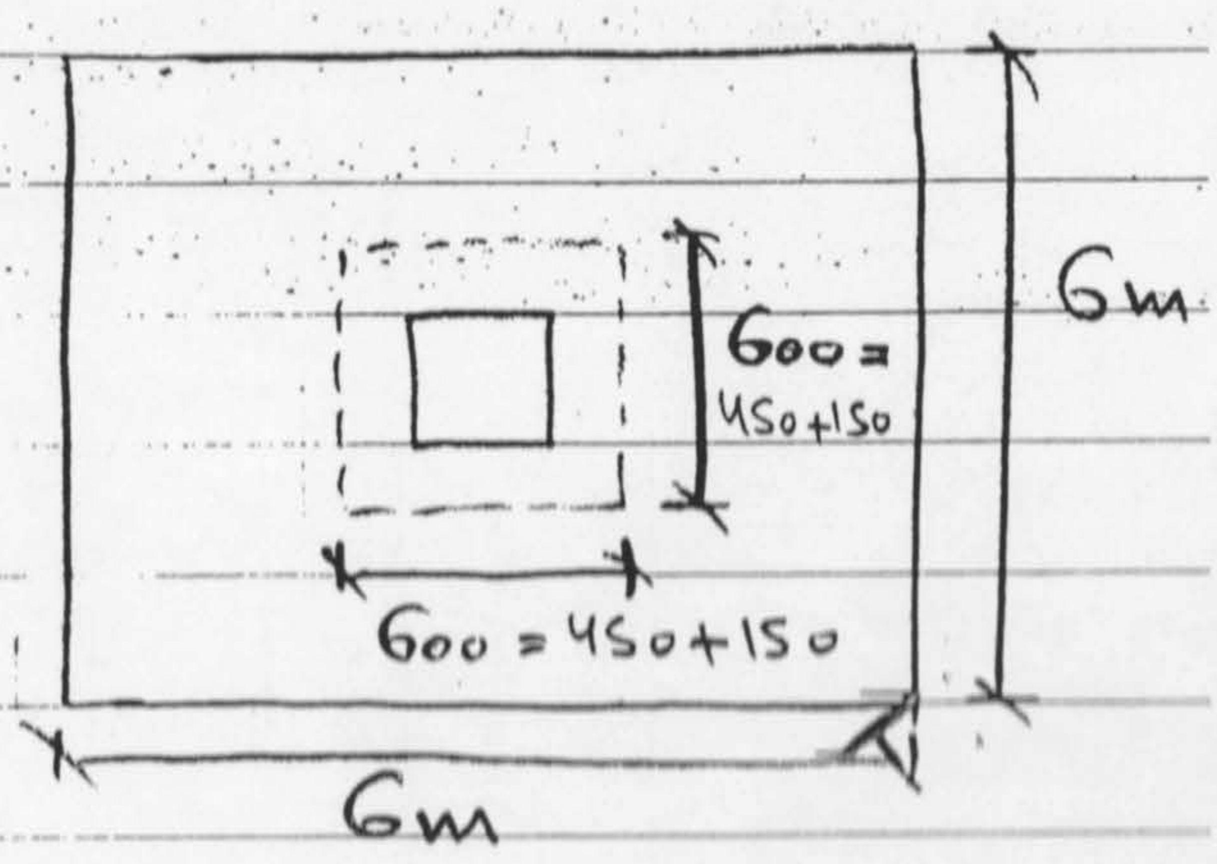
$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{1}\right)\sqrt{28} * 1650 * 150 * 10^{-3} = 667.9 \\ 0.083\left(2+\frac{30*150}{1650}\right)\sqrt{28} * 1650 * 150 * 10^{-3} = 513.8 \\ 0.33\sqrt{28} * 1650 * 150 * 10^{-3} = 432.1 \end{cases}$$

$\therefore V_c = 432.1$ kN

$V_u \leq \phi V_c$

$152.28 \leq 0.75 * 432.1 = 324.1$ kN $\therefore$ **OK**

Interior Columns



$V_u = 8\left[6*6 - 0.6*0.6\right]$

$= 285.12$ kN

$b_o = (600 + 600) * 2 = 2400$

$\beta = 450/450 = 1$

$\alpha = 40$ (interior)

$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{1}\right)\sqrt{28} * 2400 * 150 * 10^{-3} = 971.5 \\ 0.083\left(2+\frac{450 * 150}{2400}\right)\sqrt{28} * 2400 * 150 * 10^{-3} = 711.5 \\ 0.33\sqrt{28} * 2400 * 150 * 10^{-3} = 628.6 \end{cases}$$

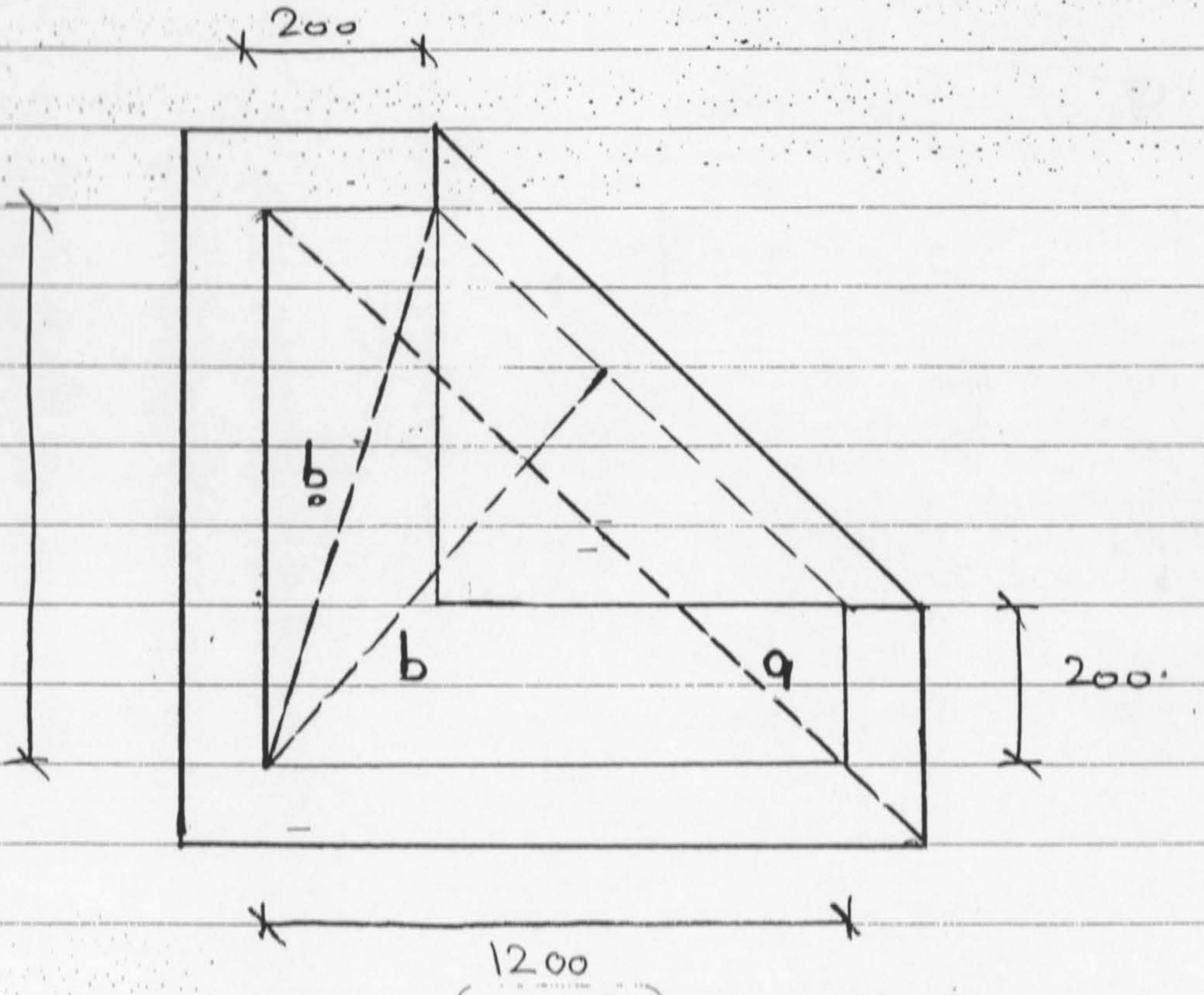
∴ $V_c = 628.6$ KN

$V_u \leq \phi V_c$

$285.12 \leq 0.75 * 628.6 = 471.5$ ∴ OK

∴ مش محتاج حديد تسليح .

Ex: Compute V_c of interior Column, $f'_c = 28$, $d = 150$ mm



* حتى نطلع ال β نحتاج أطول بعد وأقصر بعد

ال a هو البعد الطويل وهو المسافة بين ابعد نقطتين وهنا نجده باستخدام فيثاغورس.

ال b هو البعد القصير وهنا نجد ال (b_o) ونعتبره تقريباً مساوي لل b وايضاً نجده باستخدام فيثاغورس.

$a = \sqrt{600^2 + 1200^2} = 1341.6$

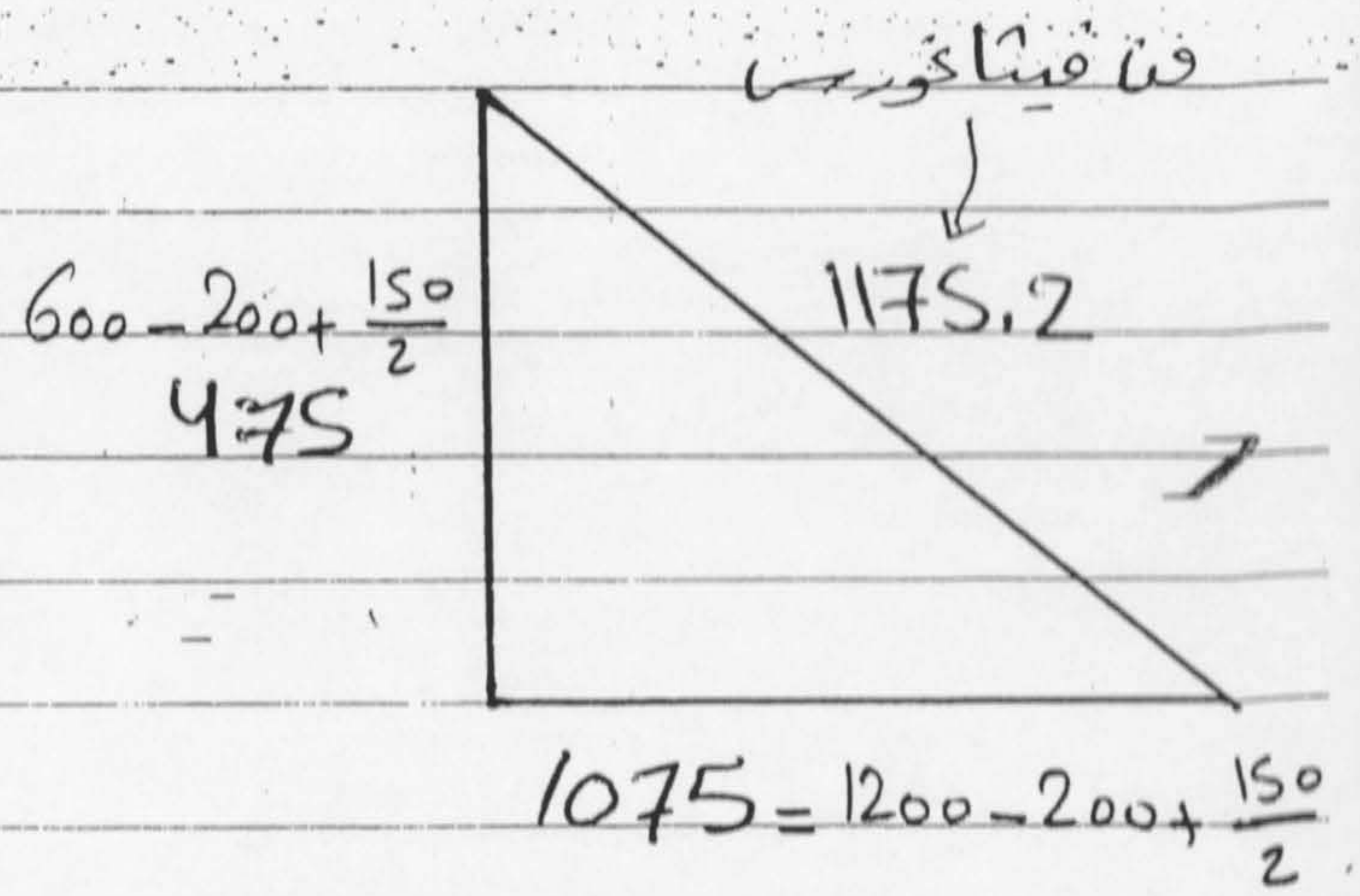
$b = \sqrt{200^2 + 600^2} = 632.4$

$\beta = \frac{1341.6}{632.4} = 2.12$

* حتى نجد ال b_o وهو محيط الشكل نحتاج ان نجد الابعاد بعد اضافة ($d/2$)

$b_o = 275 + 750 + 1350 + 275 + 1175.2$

$b_o = 3825.2$

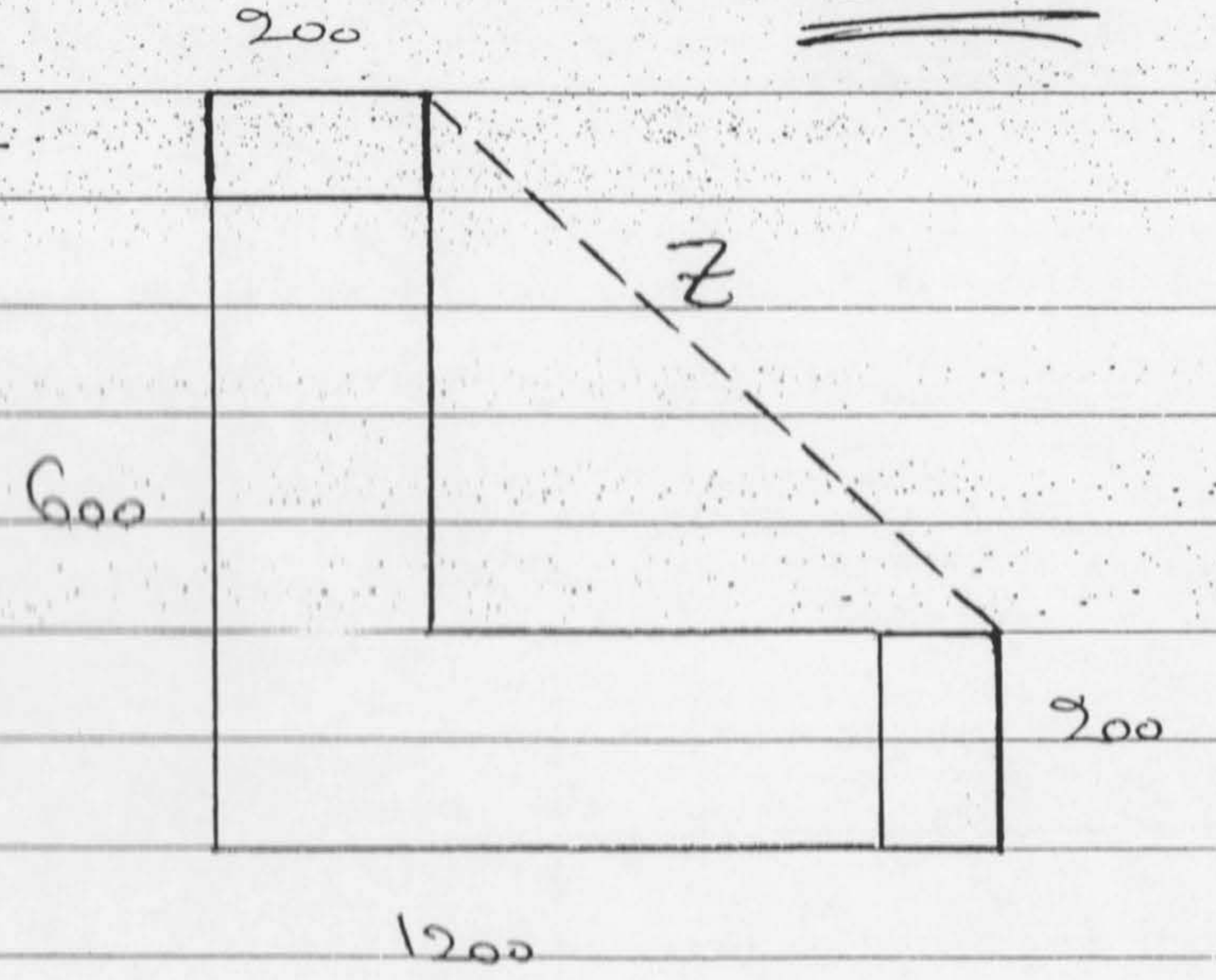


$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{2.12}\right)\sqrt{28} * 3825.2 * 150 * 10^{-3} = 1003.1 \\ 0.083\left(2+\frac{40*150}{3825.2}\right)\sqrt{28} * 3825.2 * 180 * 10^{-3} = 899.3 \\ 0.33\sqrt{28} * 3825.2 * 150 * 10^{-3} = 1001.9 \end{cases}$$

$\therefore V_c = 899.3$ kN

$\phi V_c = 0.75 * 899.3 = 674$

إذا أعمدنا كـ **Corner**



نفس الـ β

$Z = \sqrt{1075^2 + 475^2}$

$= 1175.26$

$b_o = 200*2 + 1175.26$

$= 1575.26$

$$V_c = \min \begin{cases} 413.06 \\ 405.18 \\ 412.6 \end{cases}$$

$\therefore V_c = 405.18$ kN

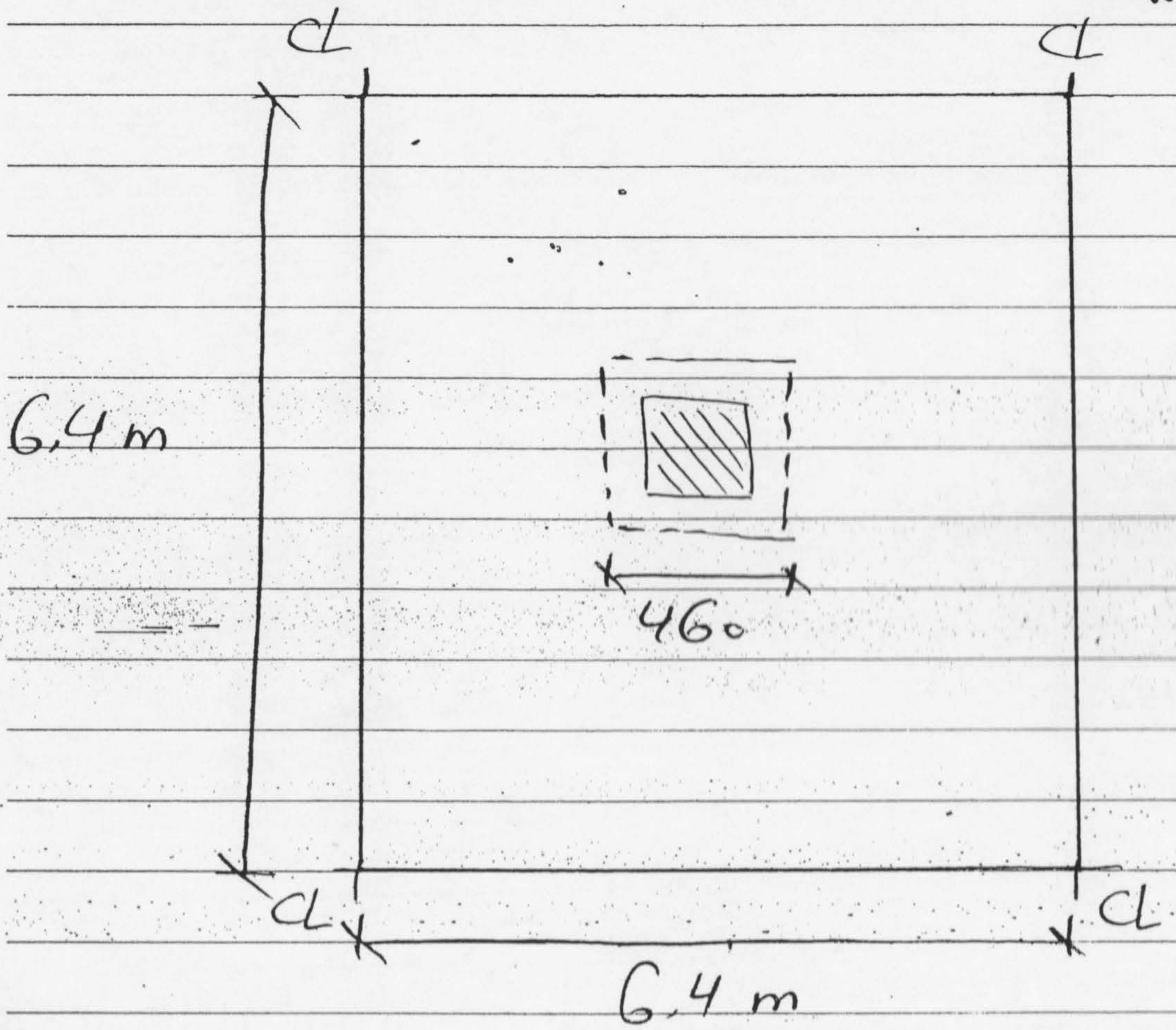
$\phi V_c = 0.75 * 405.18$

$= 303.88$ kN

20/1/2016

التاريخ / / ٢٠١   الموضوع :

Ex8 Check two-way Shear around interior Column
Column Size (300 * 300), Space Center to Center
6.4 m for each direction, $f'c = 28$, $f_y = 420$
$\omega_u = 13\ KN/m^2$, $t = 200\ mm$, $d = 160\ mm$



$V_u = \omega [A_{total} - A_1] = 13 [6.4^2 - 0.46^2] = 529.74\ KN$

$b_o = 460 * 4 = 1840$, $\alpha_s = 40$, $\beta = \frac{300}{300} = 1.0$

$$V_c = \min \begin{cases} 0.17 * (1 + 2/1) \sqrt{28} * 1840 * 160 * 10^{-3} = 794.49 \\ 0.83 \left(2 + \frac{40 * 160}{1840}\right) \sqrt{28} * 1840 * 160 * 10^{-3} = 708.33 \\ 0.33 \sqrt{28} * 1840 * 160 = 514.08 \quad 514.08 \end{cases}$$

Winner Line

529.74 $\qquad\qquad$ $\phi V_c = 0.75 * 514.08$

529.74 $\qquad\qquad$ 385.5

السمك ميجيبك تلازم تسوي تسليح

Solution no① increase strength of f'_c of Slab

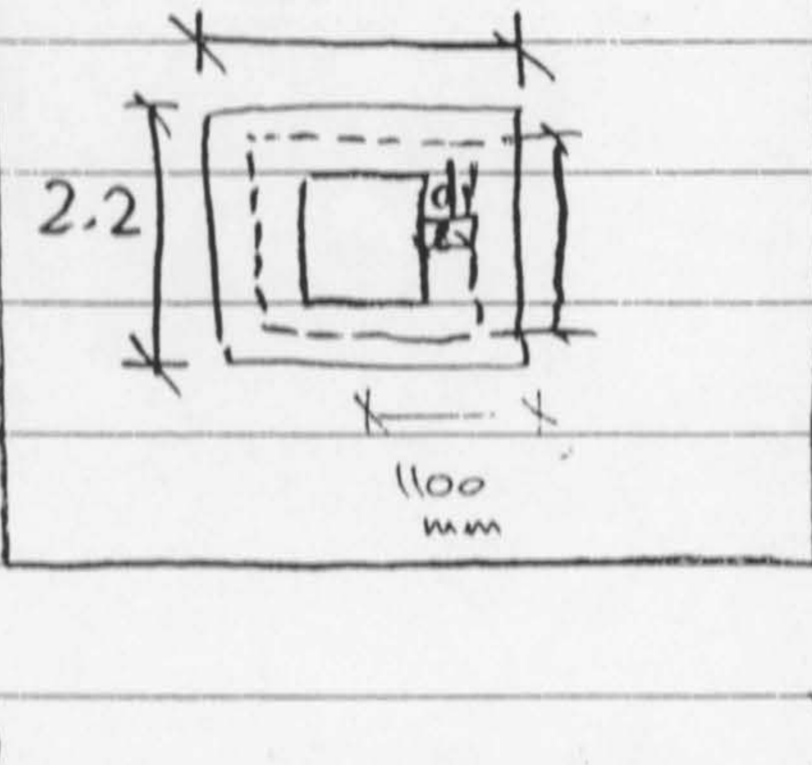
$$V_u = \phi * 0.33 \sqrt{f_c} * b_o * d$$

$$529.74 = 0.75 * 0.33 * \sqrt{f_c} * 1840 * 160 * 10^{-3}$$

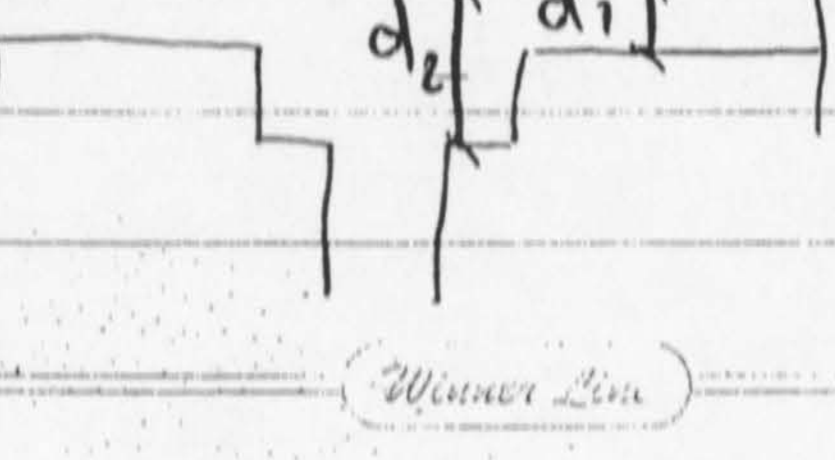
$$\sqrt{f_c} = 7.27$$

$$f_c = 52.86 < 70 \quad \therefore OK$$

Solution no② : use drop panel.



هنا نطلع المعادلة نفس drop panel
كل بعد حالة ⑥



Winner Line

thickness وخانع

$t_{drop} = \frac{t}{4} \leq t_{drop} \leq \frac{1}{4} x$

x : frome face of Support Column to end of drop panel

$\frac{200}{4} \leq t_{drop} \leq 237.5$

∴ Use $t = 52.5$

$d_1 = t_{(drop + slab)} - 20 - d_b = 252.5 - 20 - 12.5$

$d_1 = 220$ mm

عدة توكيت من الفشل

Ⓐ failure inside drop panel

مرة ندخل وزن ال droppanel

$V_u = W_{u_1}\left[\text{total Area} - A_1\right] + W_{u_2}\left[\text{total Area}_{\text{drop}} - A_1\right]$

$= 13\left[6.4^2 - 0.52^2\right] + 1.2 * \frac{52.5}{1000} * 25\left[2.2^2 - 0.52^2\right]$

$= 336.17$ KN

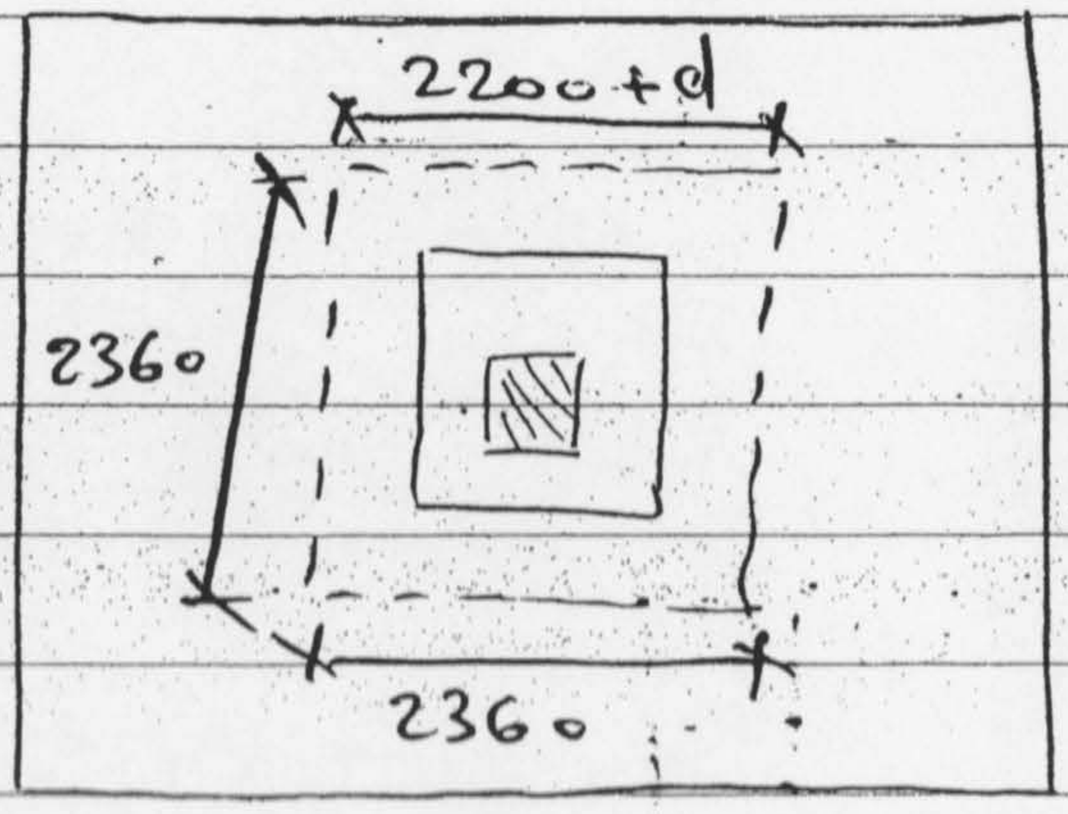
$b_o = 2080$, $\alpha_s = 40$, $\beta = \frac{300}{300} = 1.0$

$V_c = \min \begin{cases} \text{compute} \\ \text{Compute} \\ 0.73\sqrt{28} * 2080 * \underbrace{220}_{d_1} = 799 \end{cases}$

Vu ϕ Vc
536.17   0.75 * 799
536.17 < 599.3

الحالة جيكت لو طلع اكبر قلازم نزيد ال t اكتر من 52

(B) failure outside drop panel



$$V_u = 13\left[6.4^2 - 2.36^2\right] = 460 \text{ KN}$$

$a = 2200$, $b = 2200$, $\beta = \frac{2200}{2200} = 1$

$\alpha_s = 40$, $b_o = 2360 * 4 = 9440$

$$V_c = \min \begin{cases} 0.17\left(1+\frac{2}{1}\right)\sqrt{28} * 9440 * 160 * 10^{-3} = 4076 \\ 0.083\left(2+\frac{40 * 160}{9440}\right)\sqrt{28} * 9440 * 160 * 10^{-3} = 1776.5 \\ 0.33\sqrt{28} * 9440 * 160 * 10^{-3} = 2637.5 \end{cases}$$

الموضوع :　　　　التاريخ

$75 * 1776.3$

$\circ < 1332$

خارج ال drop ايضاً چيك . واذا طلعت اكبر
نكرر نستخدم ال Column Capital

Solution no. ③ : Use integral beam　البيم المخفي

$V_u = 529.74$　　$\phi V_c = 385$

$V_u \leq 0.5 \sqrt{f_c}\, b_o\, d = 0.5 * 0.5 * \sqrt{28} * 1840 * 160 * 10^{-3}$

$529.74 \leq 584$　→ * اذا آه نحتاج نسلح

* لو طالع اكبر لازم نزيد سمك المقطع.

$$V_u = \phi (V_c + V_s)$$

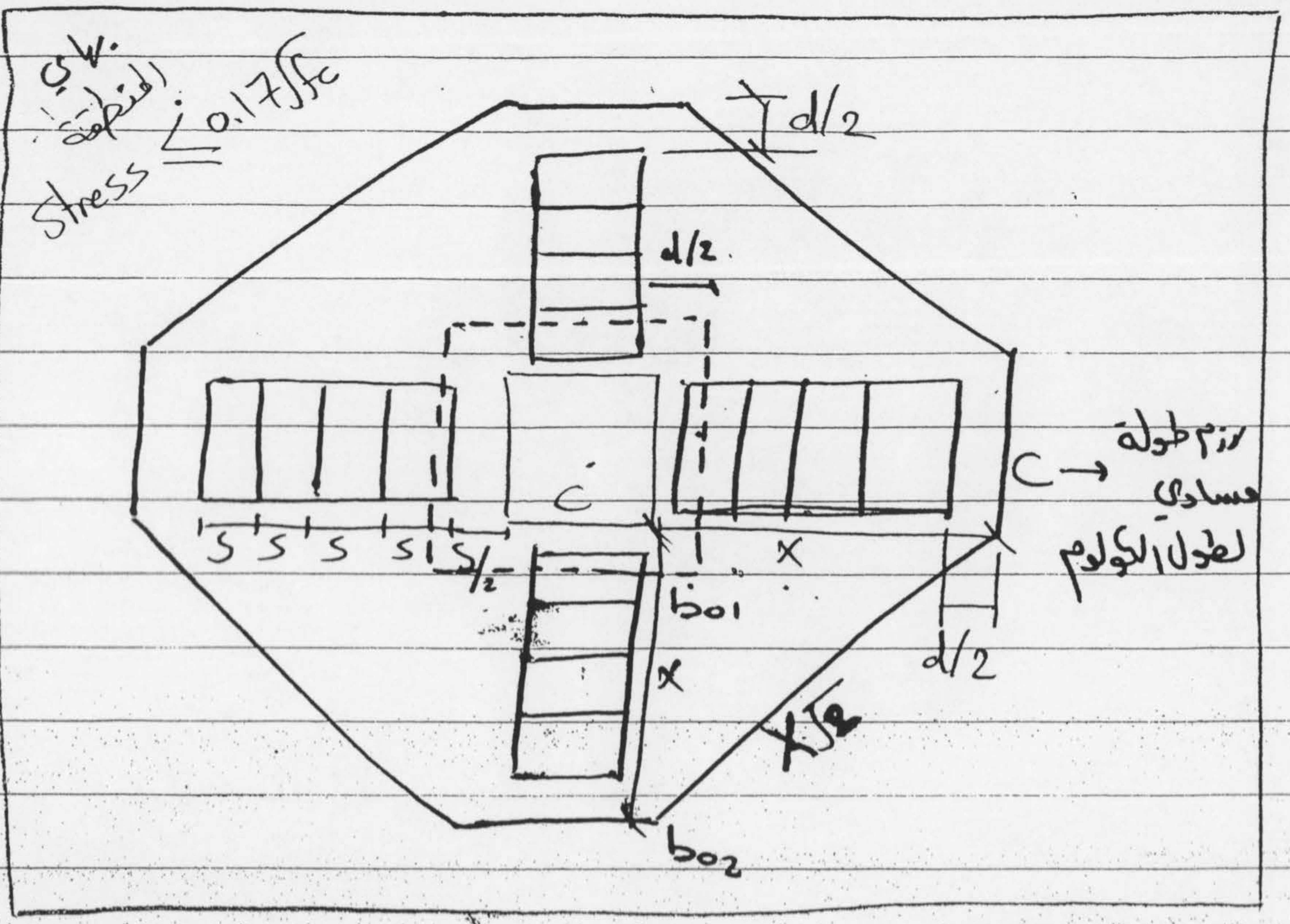
$$S = \frac{\phi A_v f_y d}{V_u - \phi V_c}$$

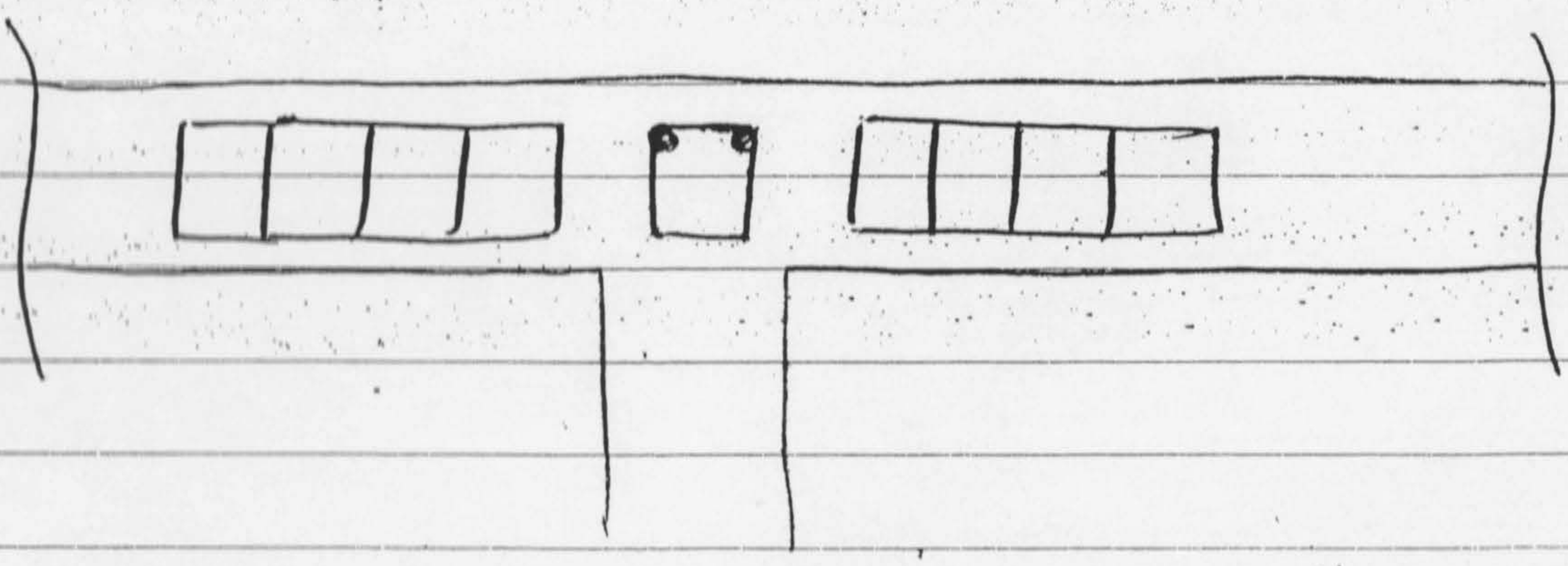
ال A_v تعني ال Stirrups نحدد عدد ن

$A_v = 8 * A_b$

↙ الرجلين للكل

٤ رجل





* الـ ϕV_c اذا ماكو تسليح لازم نطلعة من ٣ معادلات وناخذ الاصغر

لكن لو وجود تسليح نستخدم معادلة واحدة،

Winner Line

$$\phi V_c = \phi * 0.17 \sqrt{f_c}\, b_{o1}\, d$$
$$= 0.75 * 0.17 * \sqrt{28} * 1840 * 160 * 10^{-3}$$
$$= 198.6$$

$$S = \frac{0.75\,(8*78) * 420 * 160}{529.74 - 198.6}$$

$$= 94.9 > S_{max} = \frac{d}{2} = \frac{160}{2} = 80$$

$$\therefore S = 80$$

$$\phi V_u = \phi * 0.17 * \sqrt{f_c} * b_{o2} * d$$

$$529.74 = 0.75 * 0.17 * \sqrt{28} * b_{o2} * 160 * 10^{-3}$$

$$\therefore b_{o2} = 4907.4$$

X

no. of Strirups in one direction $= \dfrac{\left[\dfrac{b_{o2}}{4} - C\right] * \dfrac{1}{\sqrt{2}} - \dfrac{d}{2}}{S}$

$$= \frac{\left[\frac{4907}{4} - 300\right] * \frac{1}{\sqrt{2}} - 80}{80} = 7.1$$

= 8 bars

$\therefore b_{o_2\,actual} = 5046$

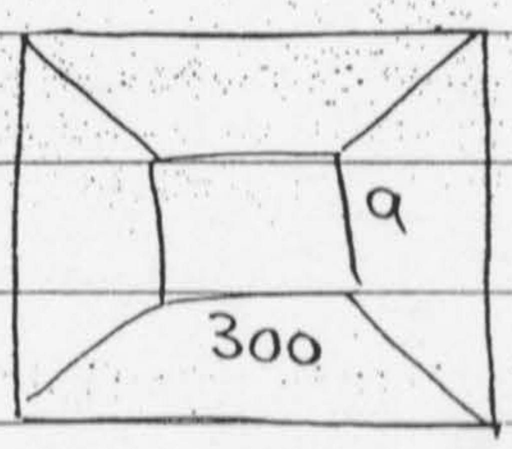
Solution no. 4 : Use Column Capital.

$V_u = 529.74$

$V_u = 0.75 * 0.33 * \sqrt{28} * b_o * 160 * 10^{-3} = 529.74$

$\therefore b_o = 2528.1$

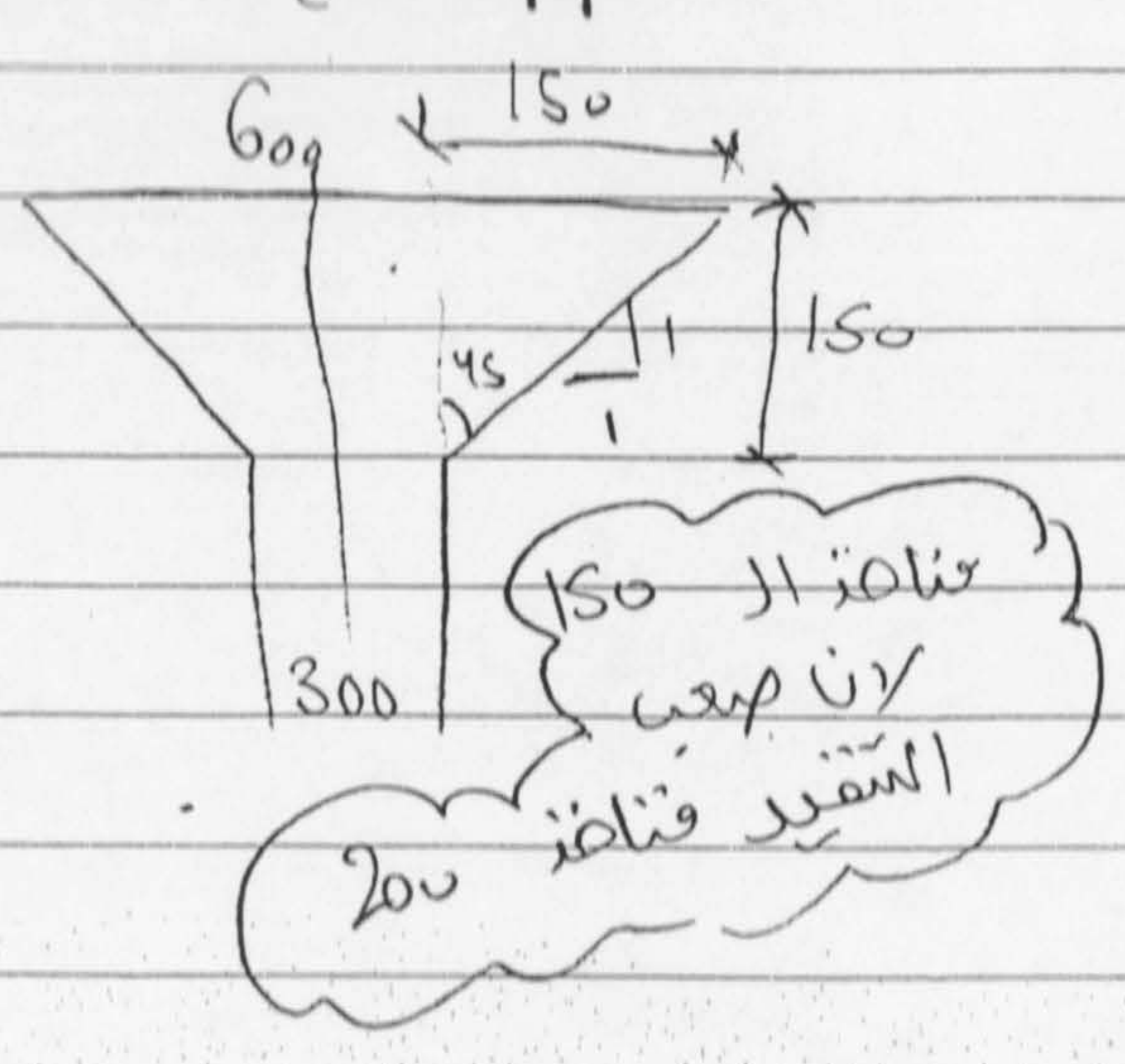
$2528.1 = (a + d) * 4$

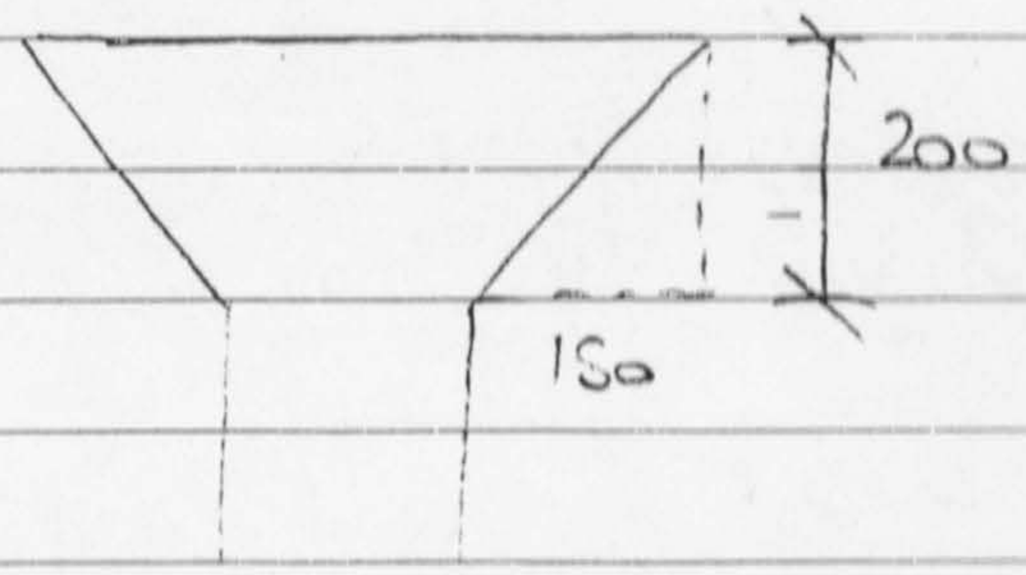


$a = \frac{2528.1}{4} - 160$

$a = 472.1$

ملاحظة مهمة [لازم نحسب ال depth تابع ال droppanel]

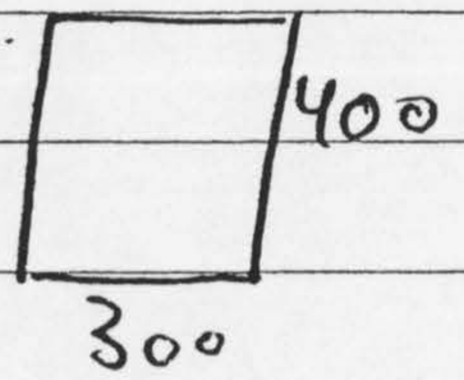




الزاوية ع تكون اكبر من 45° فالكل تمام.

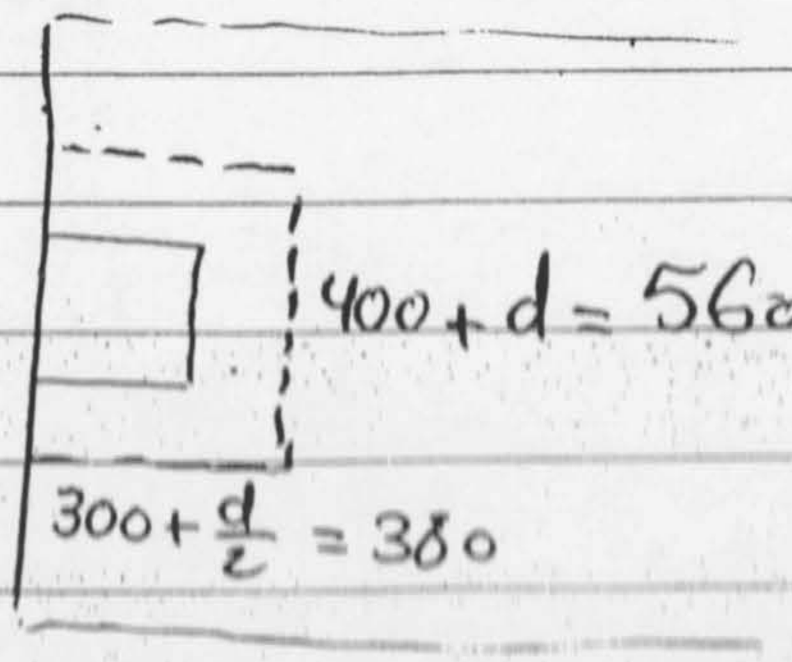
Ex: Check punching shear in slab around edge column

$V_u = 350$, $f_c = 30$, $f_y = 450$, $t = 200$, $d = 160$



احنا عندنا V_u ومحتاج V_c عشان نعرف بيحصل punching ولا.

$b_o = 560 + 380 * 2 = 1320$



$V_c = \min \begin{cases} \text{computed} \\ \text{computed} \\ 0.33 * \sqrt{30} * 1320 * 160 * 10^{-3} = 381.7 \end{cases}$

V_u	ϕV_c
350	$0.75 * 381.7$
350	> 286.2

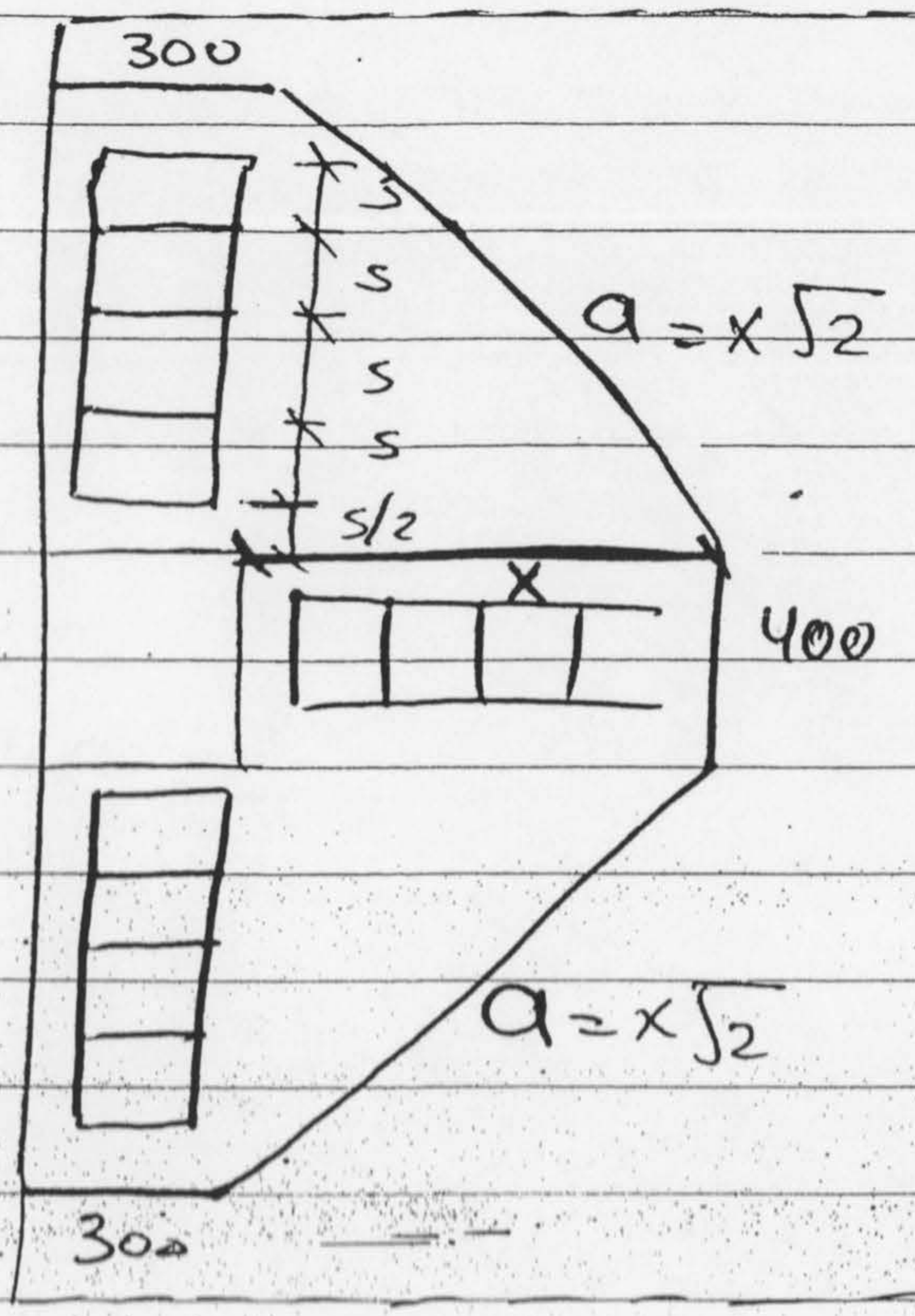
اذا نحتاج تسليح

نروح نقارن ال $V_u < \phi * 0.5 * \sqrt{f_c} * b_o * d$

$350 < 433.7$

لا نحتاج تسليح ، ولو طلعت اكبر لازم نزيد السمك.

Winner Line



* رح نعتبر التوزيع مائل بزاوية 45°

$$S = \frac{\phi * d * A_v * f_y}{(V_u - \phi V_c) * 10^3} = \frac{0.75 * 160 * (78 * 6) * 420}{(350 - 147.3) * 10^3}$$

$$S = 116.4 > S_{max} = \frac{d}{2} = \frac{160}{2} = 80$$

$\therefore S = 80$

$d > 150$

$\geq 16\, d_b$

Winner Line

$b_{o_2} = 300 * 2 + 400 + 2a$

$b_{o_2} = 1000 + 2a$

$V_u = 350 = \phi * 0.17 * \sqrt{30} * b_{o_2} * 16 * 10^{-3}$

$b_{o_2} = 3132.4$

$1000 + 2a = 3132.4$

$2a = 2132.4$

$\therefore a = 1066.2$

$a = x\sqrt{2}$

$x = \frac{1066}{\sqrt{2}} = 723.9$

$\text{No. of stirrups} = \frac{x - d/2}{s}$

$= \frac{723.9 - 80}{80} = 8.4$

use (9)

* اول Stirrups لازم يكون اقل من اصفة $\frac{d}{2}$
رح ناخذه S/2 .

* لازم نطلع قيمة ال X ونقارنها مع ال X الاصلية
اذا اكبر فاحنا بال Save Side واذا اصغر

Winner Line

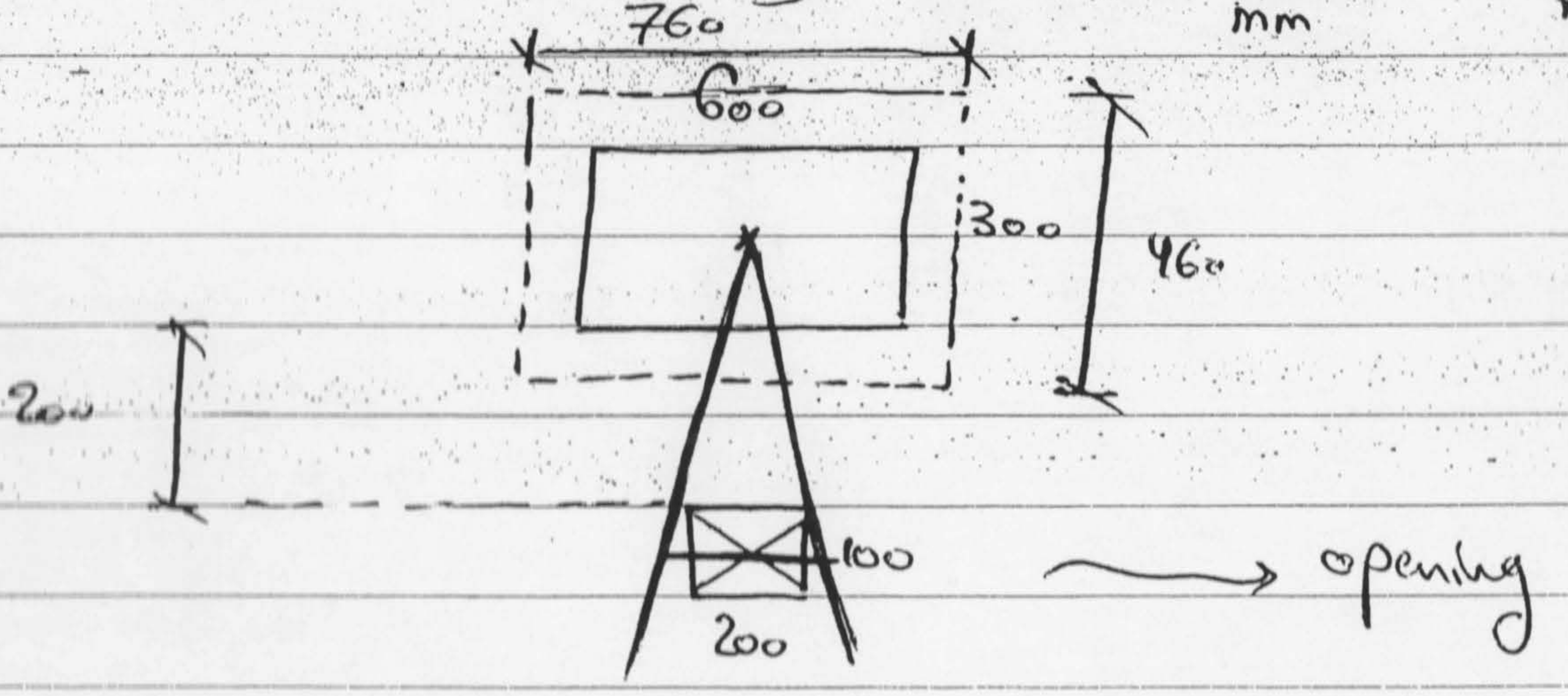
$X_{actual} = 8.5 * 80 + \frac{d}{2}$

$= 760 > 753.9$

∴ OK

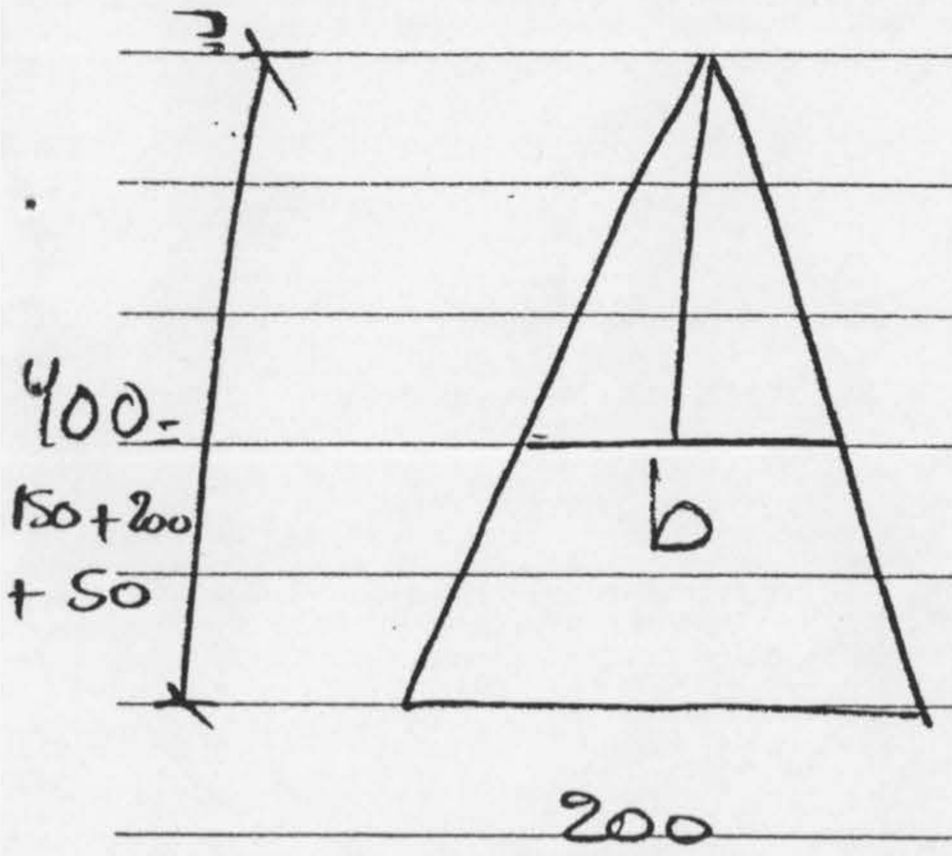
Ex 8 Check punching shear in slab around interior Column

$V_u = 250,\ f_c = 30,\ f_y = 420,\ t = 200\ mm,\ d = 160\ mm$



هنا سنتر الكولوم رح نرسم اشعة لحافة الفتحة واللي
داخل ضمن الاشعة مبدخل ضمن ال bo (محيط القص)

Winner Line



$150 + 80 = 230$

$\frac{b}{230} = \frac{200}{400}$

$b = 115$

$b_o = (760 + 460) * 2$
$= 2440$

$b_{o1} = 2440 - 115 = 2325$

$V_c = \min \begin{cases} \text{computed} \\ \text{computed} \\ 0.33 * \sqrt{30} * 2325 * 160 * 10^{-3} \end{cases}$

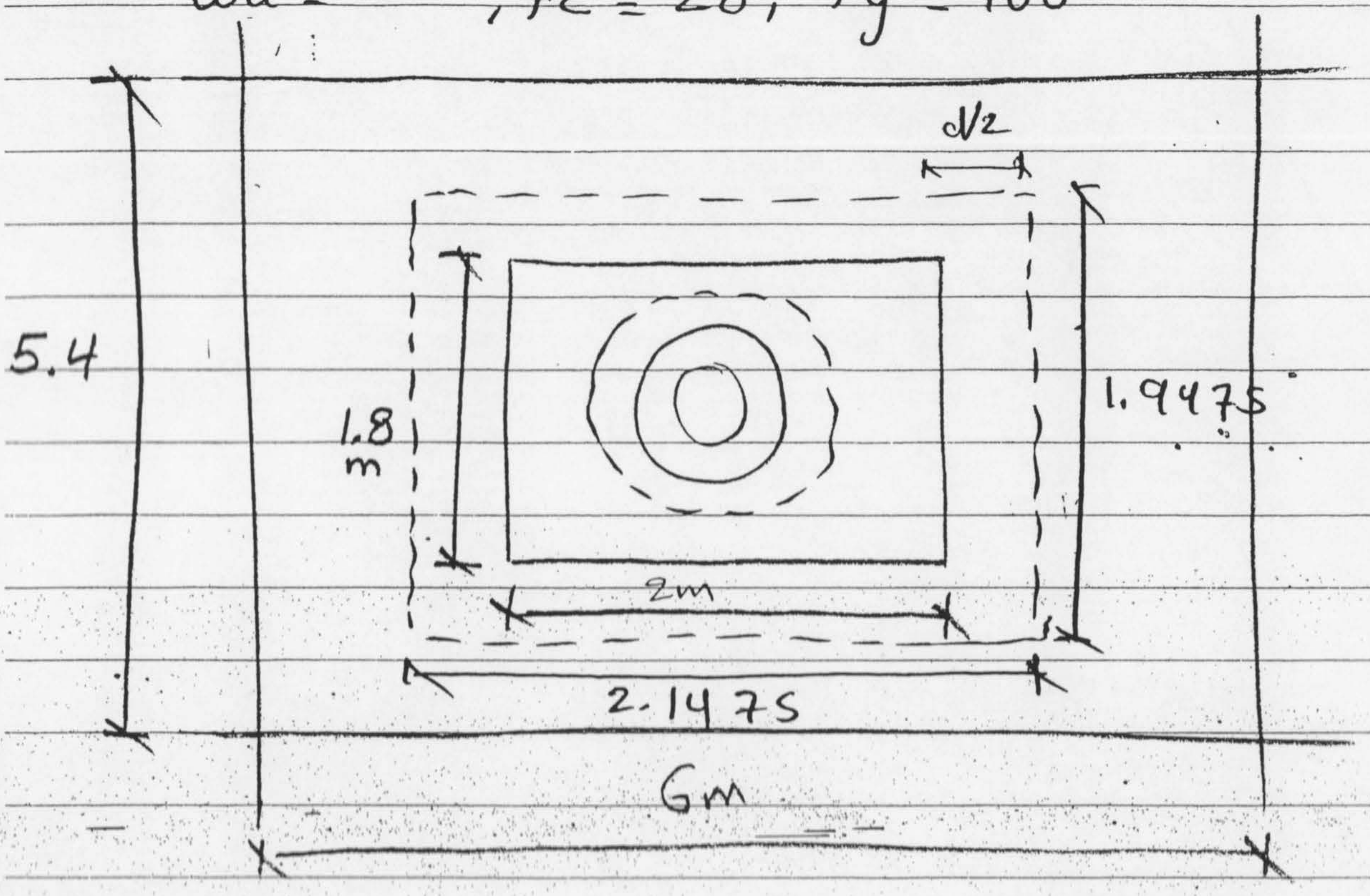
$V_c = 762.3$

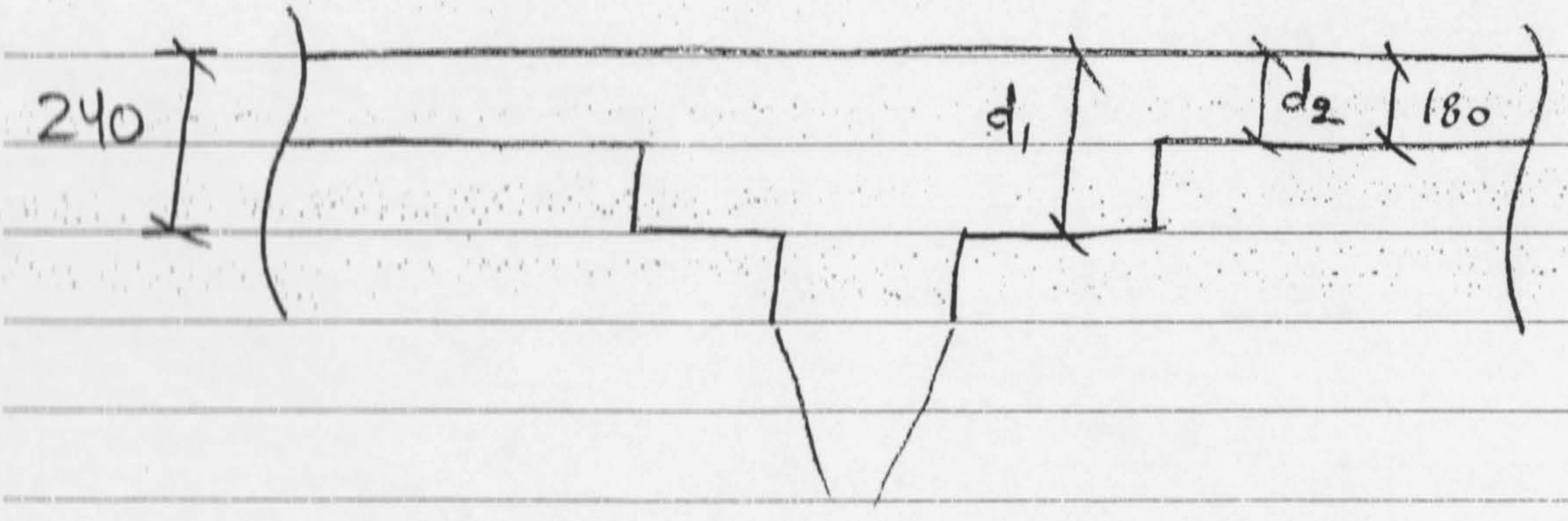
V_u		ϕV_c
250		$0.75 * 672.3$
250	<	504.3

مو محتاج تسليح.

Ex 8 Interior Column

$w_u = 15$, $f_c = 28$, $f_y = 400$

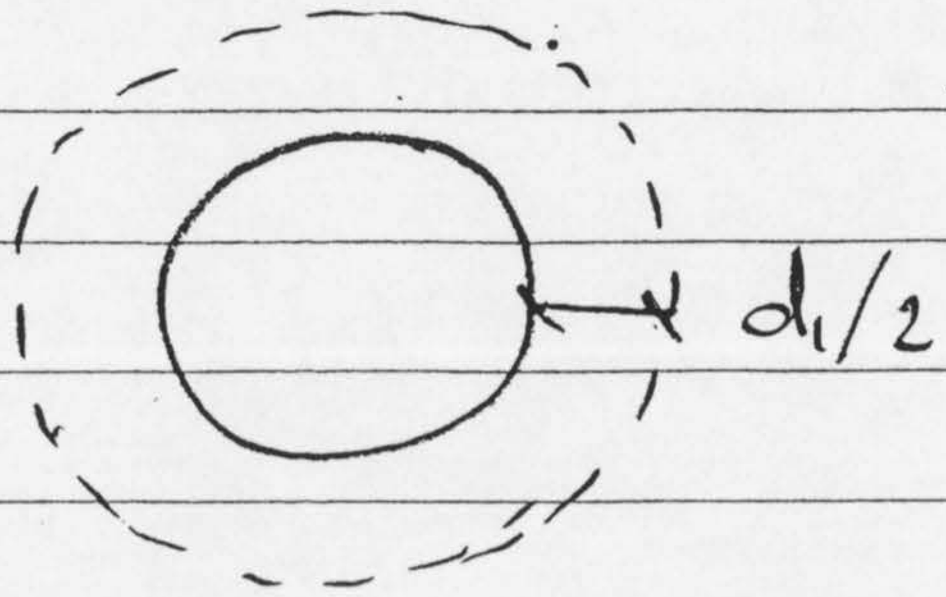




$d_1 = t - 20 - d_b$
$= 240 - 20 - 12.5$
$= 207.5$

$d_2 = 180 - 20 - d_b$
$= 147.5$

اول مقطع رح يصير داخل
ال drop panel



$$V_u = 15\left(6*5.4 - \frac{1.2075^2*\pi}{4}\right) + 1.2*\frac{60}{1000}*25\left(2*1.8 - \frac{1.2073^2\,\pi}{4}\right)$$

$V_u = 473.2$

$b_o = 1.2075 * \pi = 3793$

$d = 207.5$

$\alpha_s = 40 \, , \, \beta = 1$

$$V_c = \min \begin{cases} \text{Computed} \\ \text{Computed} \\ 0.33 * \sqrt{28} * 3793 * 207.5 \times 10^{-3} \\ = 1374.3 \end{cases}$$

$V_u \quad \phi V_c$

$473.2 < 1030.8$

المقطع التاني خارج ال drop panel

$$V_u = 15\left[6*5.4 - 2.1475*1.9475\right] = 423$$

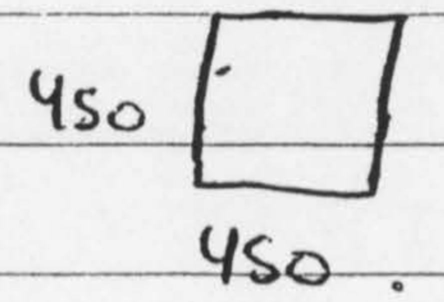
$b_o = (2147.5 + 1.9475) * 2$

$\alpha_s = 40$

$\beta = 2/1.8 = 1.1$

Ex: Check Punching Shear in Slab around interior Column and find Reinforcement it need

$d = 150$ mm , $f_c = 28$, $V_u = 487$, f_y



(1) ال Vc من ٣ معادلات
نجدها وناخذ الاصغر
ونضربة ب ϕ ونقارن مع Vu

Vc → (1)
Vc → (2)
Vc → (3)

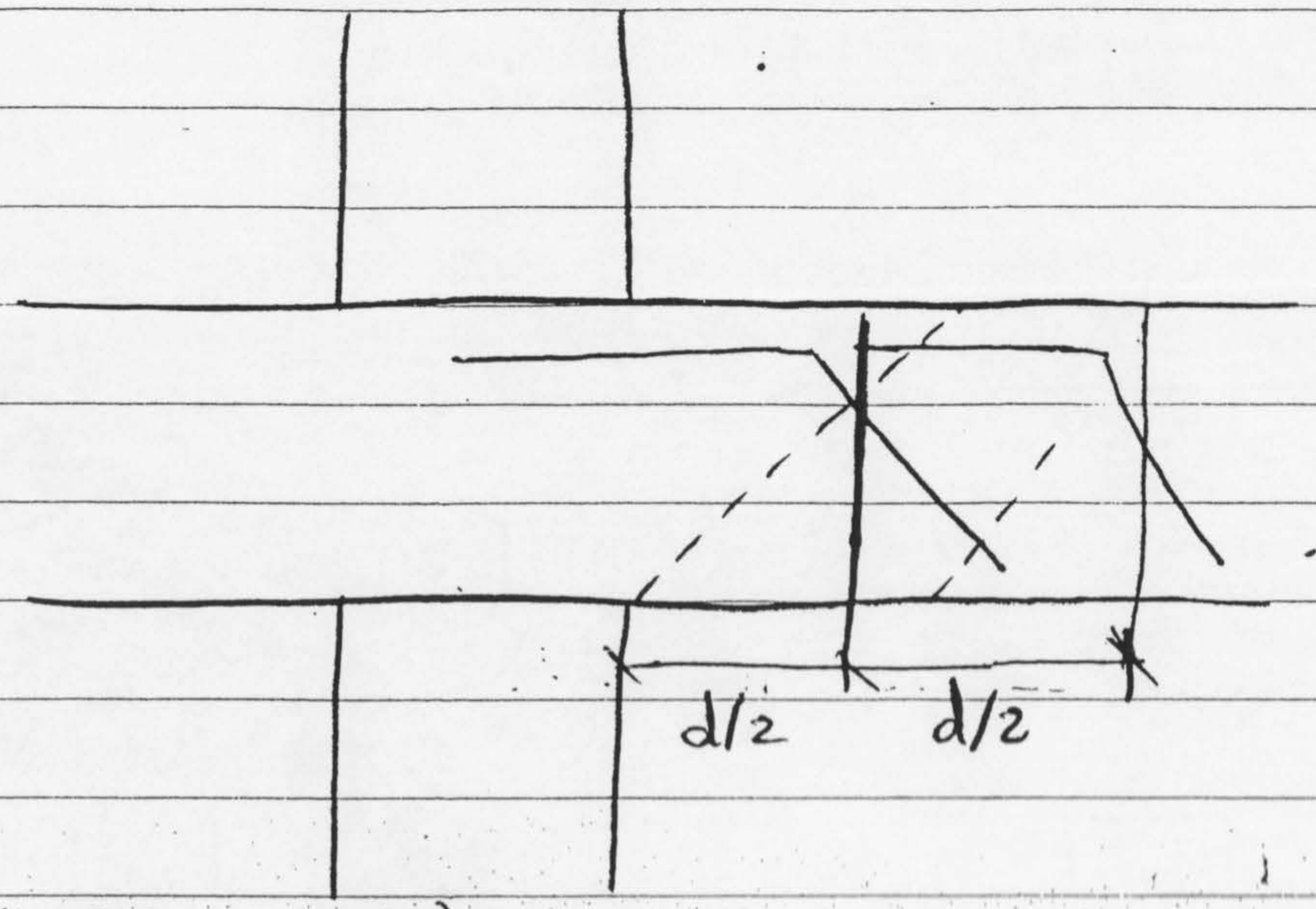
$\phi V_c = 471$

$V_u > \phi V_c$ ∴ نحتاج تسليح

(2) لازم نشيك

$V_u \leq \phi\, 0.5 \sqrt{f_c}\, b_o\, d$

≤ 713.61



$V_u = \phi(V_c + V_s)$

$V_u = \phi V_c + \phi V_s$

$\phi V_s = V_u - \phi V_c$

$V_s = \dfrac{V_u - \phi V_c}{\phi}$

$A_v f_y = \dfrac{V_u - \phi V_c}{\phi}$

$A_v = \dfrac{V_u - \phi V_c}{\phi f_y}$ horizontal Reinf.

$A_v = \dfrac{V_u - \phi V_c}{\phi \sin\phi \, f_y}$ vertical Reinf.

$V_c = \phi * 0.17 \sqrt{f_c} \, b_o d$

Winner Line

$$\phi V_c = 471 * \frac{0.17}{0.33} = 243$$

$$V_s = \frac{487 - 243}{0.75} = 325$$

التسليح

Vertical ⊓⊔⊓ .... bent

$- A_v = \frac{V_s}{\phi f_y}$

$V_u < 0.5\sqrt{f_c}\, b_o d$ ∴ OK

$V_u > 0.25\sqrt{f_c}\, b_o d$

$$A_v = \frac{V_s}{\phi \sin\phi\, f_y}$$

* ال Crack يقطع ال bar مرة أو مرتين.

* ال Crack يقطع ال bar 8 مرات

note بال bent أجيك مرتين وبالباقي أجيك مرة وحدة.

خطوات الحل :

١) نحسب الـ V_u
٢) نحسب V_c من ٣ معادلات.
٣) نختار أقل V_c
٤) نقارن ϕV_c مع V_u اذا كانت ϕV_c اكبر من V_u فنحتاج تسليح واذا اصغر نحتاج تسليح.

٥) نجيك لازم $[V_u \leq \phi\, 0.5 \sqrt{f_c}\, b_o d]$ اذا كانت $[V_u > \phi\, 0.5 \sqrt{f_c}\, b_o d]$ لازم نسوي increase depth of Slab

عارفين في بعض فين ناقصني ايه وايه
مش لاقيه حد ذي اهتم بعد بيه
ناقصني اي حاجة وبعد كل حاجة
بلاقي نفسي برضو بحن اليه

أحلف بايه منا بعد عايشة ع اللي فات
وكل يوم أنا بفتكلو كتير حاجات
ناقصني اي حاجة وبعد كل حاجة
بلاقي نفسي برضو بحن ليه.

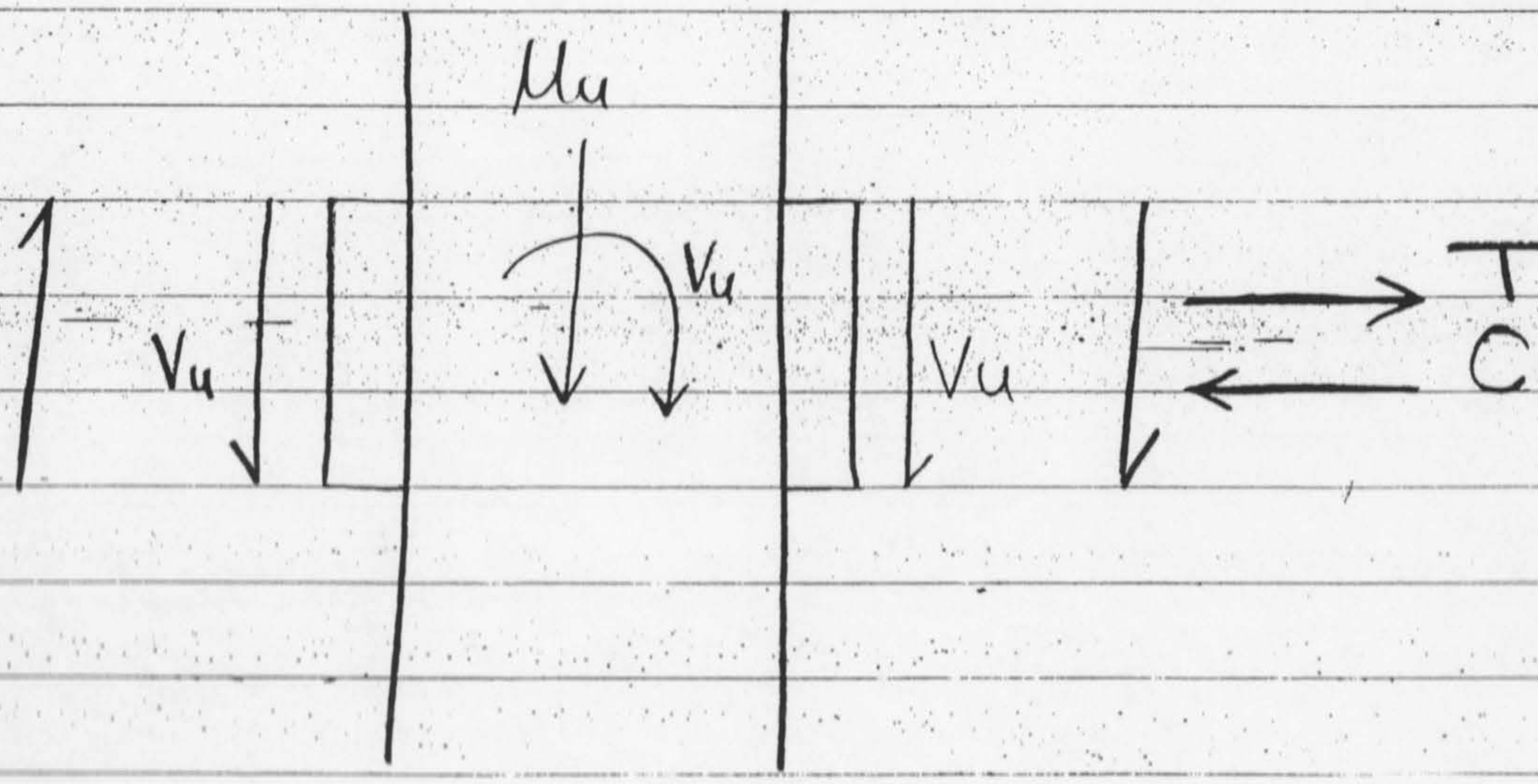
حدا اللي عدا برضو لسا ما انستوش
بشوف فلاقي ليه هنا بكل الوشوش

Transfers of moment to Columns

(Slab - Column Connection)

يحصل في الحالات التالية

1. flat Plate
2. flat Slab
3. Slab beam system $\alpha \frac{L_2}{L_1} < 1.0$ عندما يكون البيم ضعيف

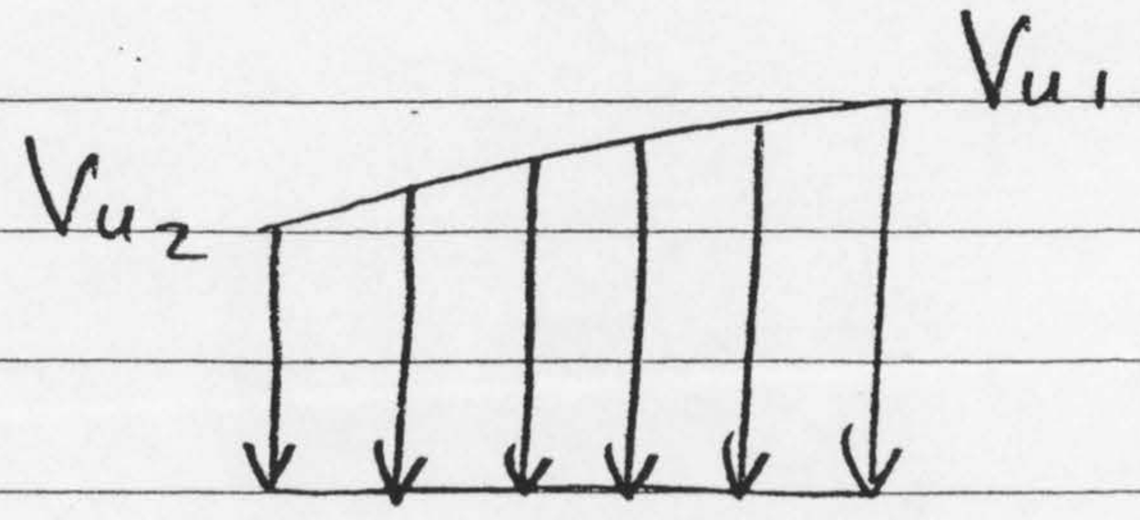


يحدث الـ M balance

١) من الـ earthquke , wind load

٢) exterior

٣) Side load



العزم جزء منه يروح لل Shear والجزء الآخر يروح لل flexture

$$V_{u1} = \frac{V}{b_o d} + \frac{\gamma_v M_u C_1}{J}$$

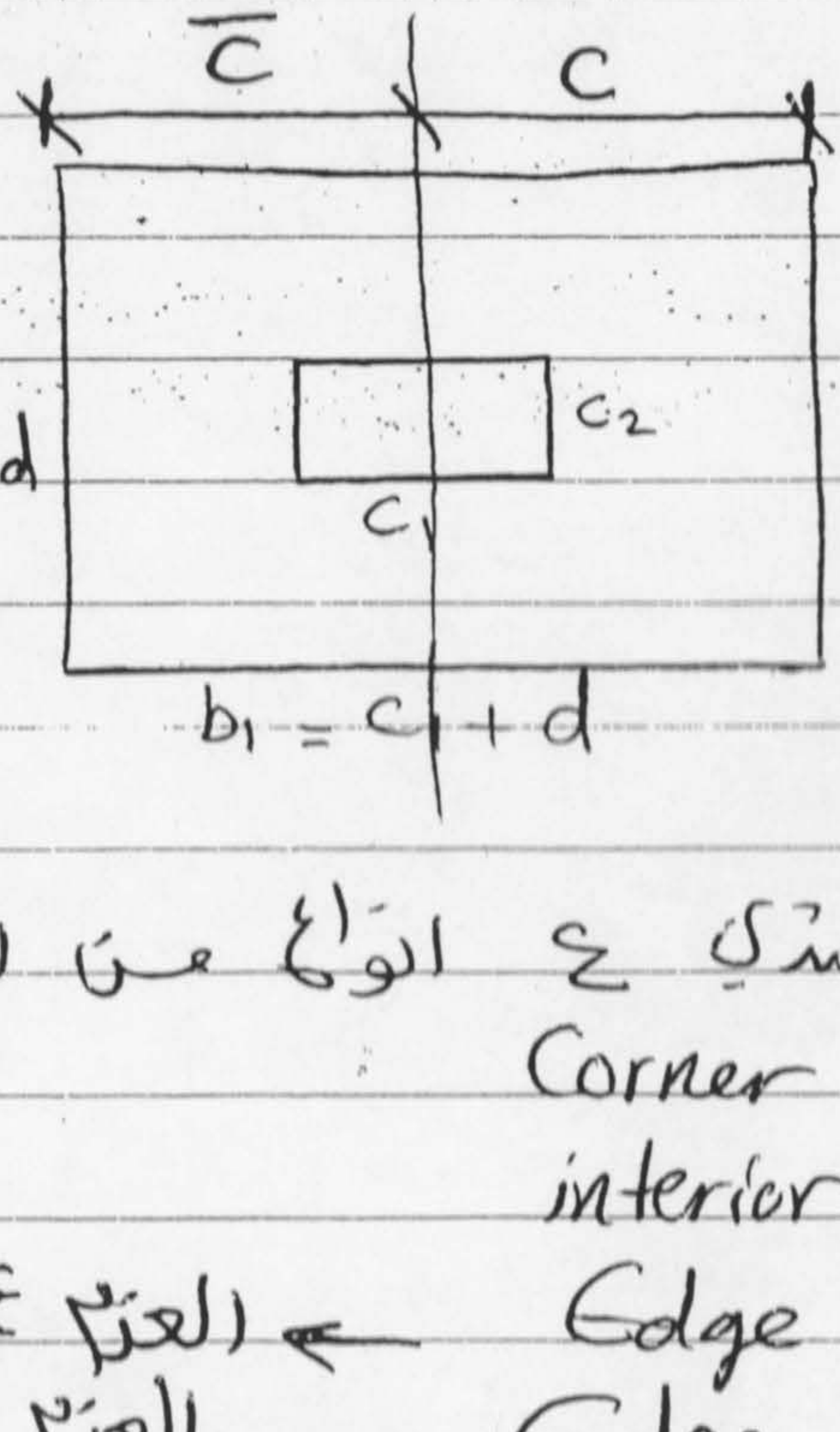
$$V_{u2} = \frac{V}{b_o d} - \frac{\gamma_v M_u C_2}{J}$$

J: Polar moment of inertia.

$$J_c = I_{\bar{x}} + I_J$$

$$J = A\bar{x}^2 + J_c$$

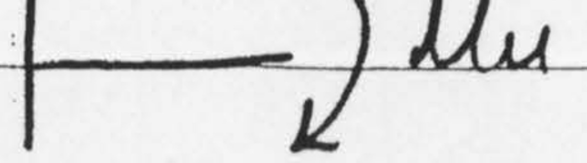
$b_2 = c_2 + d$



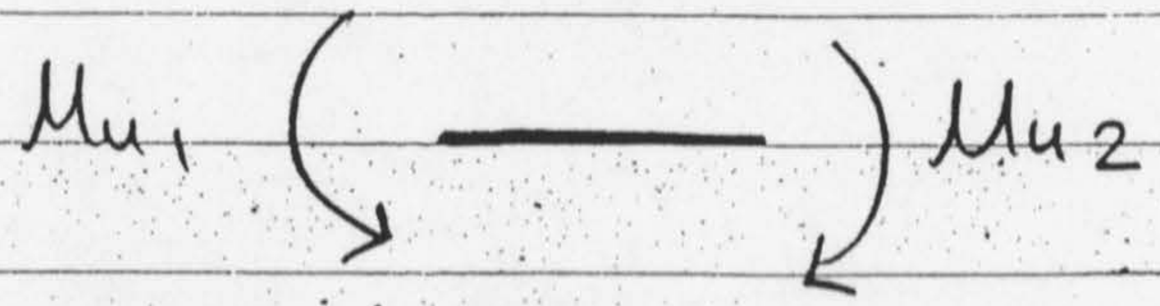
عندي ٤ انواع من الاعمدة.

① Corner
② interior
③ Edge ← العزم عمودي ع الكولوم.
④ Edge ← العزم موازي للكولوم.

* في حالة الـ edge يكون الـ M_u = Mbalance
من جهة واحدة.



* في حالة الـ interior يكون عندي عزم من الجهتين
(فقط أول interior) ويكون الفرق بين العزمين
هو Mbalance (M_u)



$$M_u = M_{u1} - M_{u2}$$

اذا كانت الابعاد متساوية فان باقي الكولوم interior شبيهة
Moment transfer لان العزم متساوي من الجهتين.

احنا اللي يهمنا هو V_u (1) نفترضه ونقارن بينه وبين
الـ ϕV_c

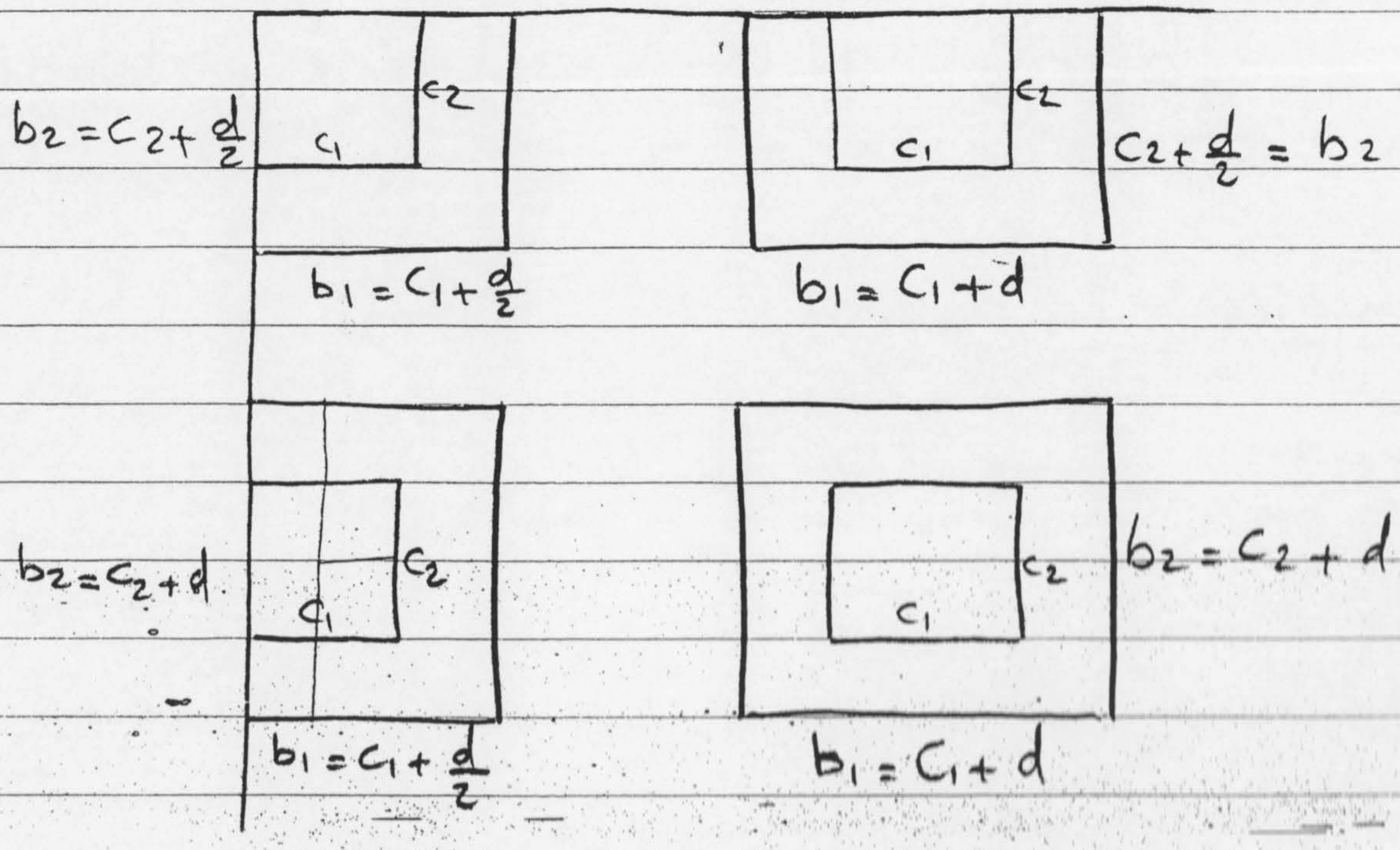
$$V_u \leq \min \phi \begin{cases} eq\ (1) \\ eq\ (2) \\ eq\ (3) \end{cases} \quad \text{no need Reinforcement}$$

$V_u > \min \phi$ need Reinforcement

$V_u \leq \phi \ 0.5 \sqrt{f_c}\ b_o d$

Winner Line

الجانبي للتسليح b_1 والعمودي b_2 :



نذهب للجدول الموجود بالملزمة ونجد

عند b_1 , b_2 , d

من الجدول $J , C , C' , (J/c , J/c')$

$$V_u = \frac{V}{bd} \mp \frac{\gamma_{vy} M_{uy} C_y}{J_y} \mp \frac{\gamma_{vx} M_{ux} C_x}{J_x}$$

γ_f : Part of unbalaced moment taken by flaxture (bending).

γ_v : Part of unbalaced moment taken by shear

. bending ← يروح 60% بالكولوم داخلي

. Shear ← يروح 40%

$$\gamma_f = \frac{1}{1 + \frac{2}{3}\sqrt{\frac{b_1}{b_2}}}$$

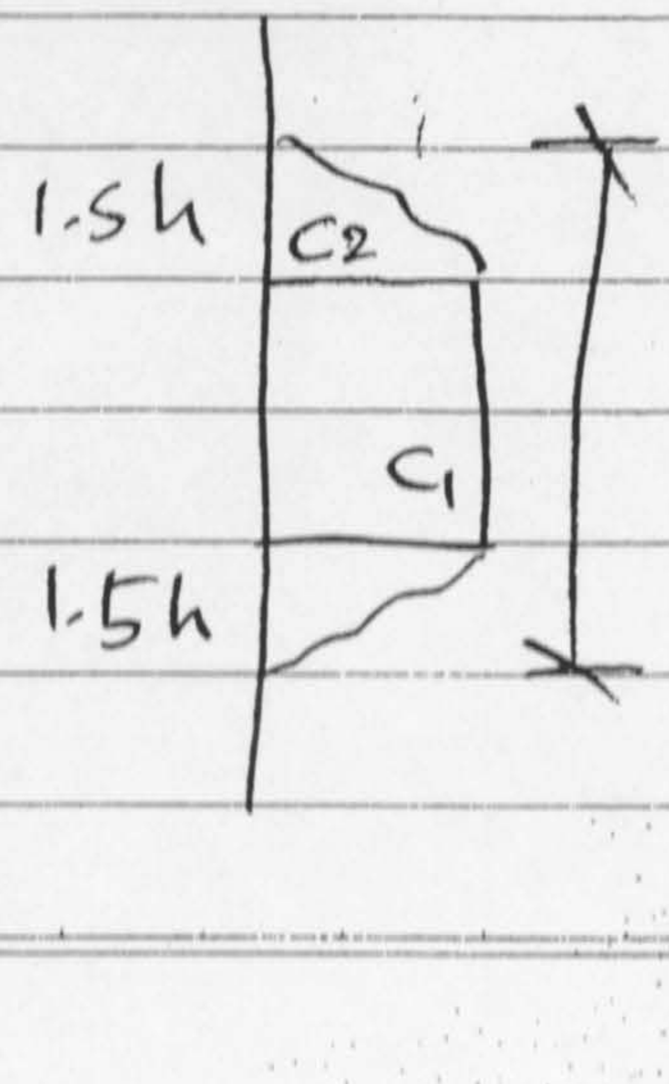
$$\gamma_v = 1 - \gamma_f = 1 - \frac{1}{1 + \frac{2}{3}\sqrt{\frac{b_1}{b_2}}}$$

if $V_u < 0.75 \phi V_c \Rightarrow \gamma_f = 1$

Case C

* في حالة ال edge

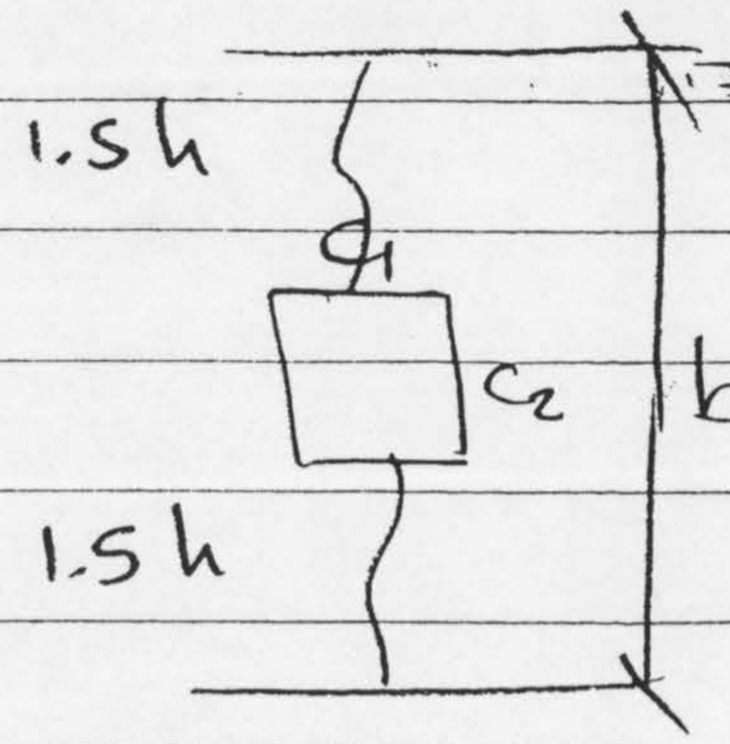
([illegible] عمودي)



$b = C_2 + 3h$

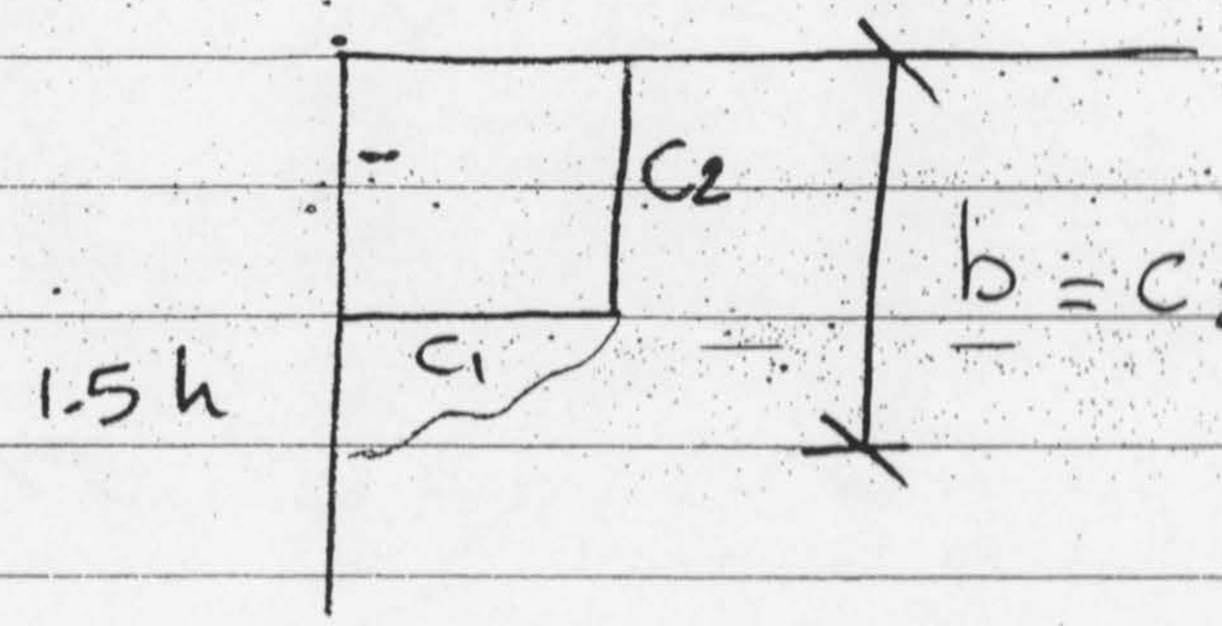
Winner Line

حالة ال interior :



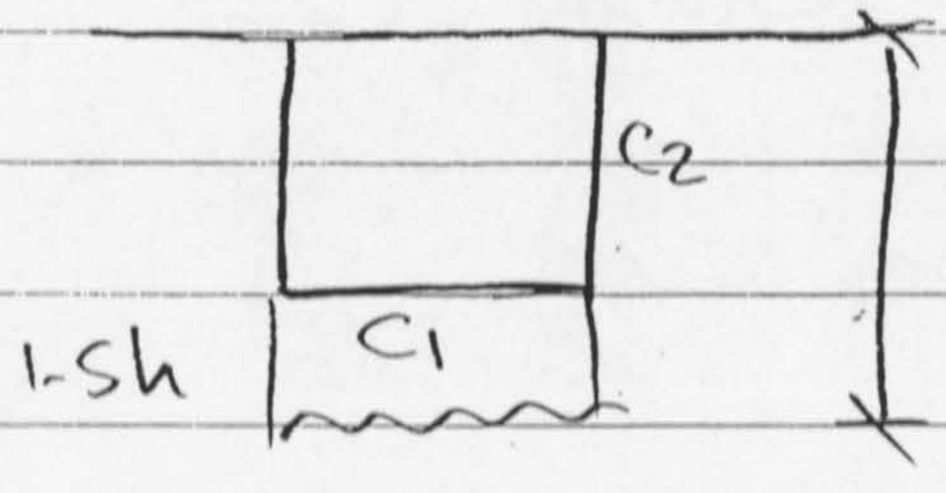
$b = c_2 + 3h$

حالة Corner :



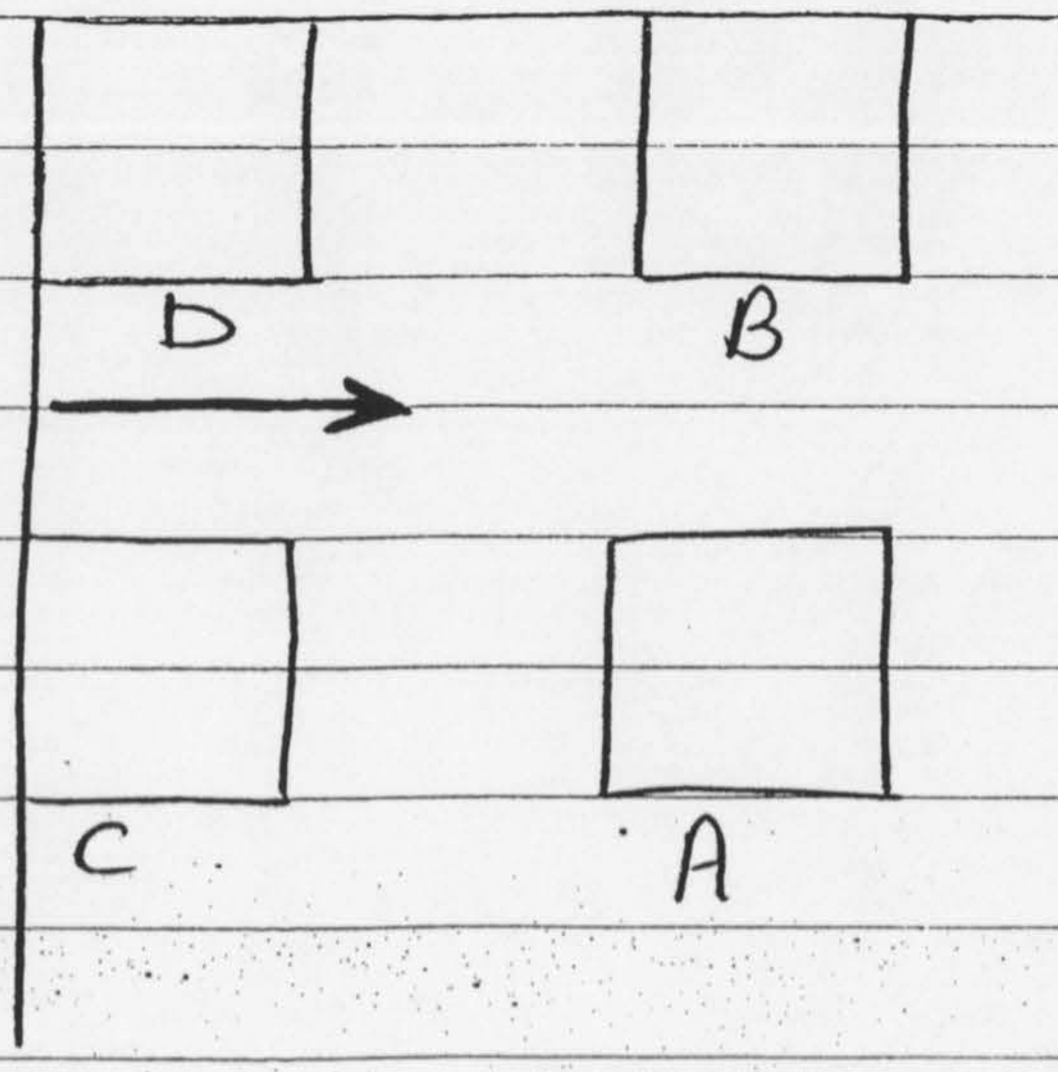
$b = c_2 + 1.5h$

حالة edge (توفيت موازي)



$b = c_2 + 1.5h$

(Mu) moment unbalanced حساب



for A, B

$$Mu = 0.07\left[(wd + 0.5\,wl)\, l_2\, l_n^2 - wd'\, l_2'\, l_n'^2\right]$$

for CD

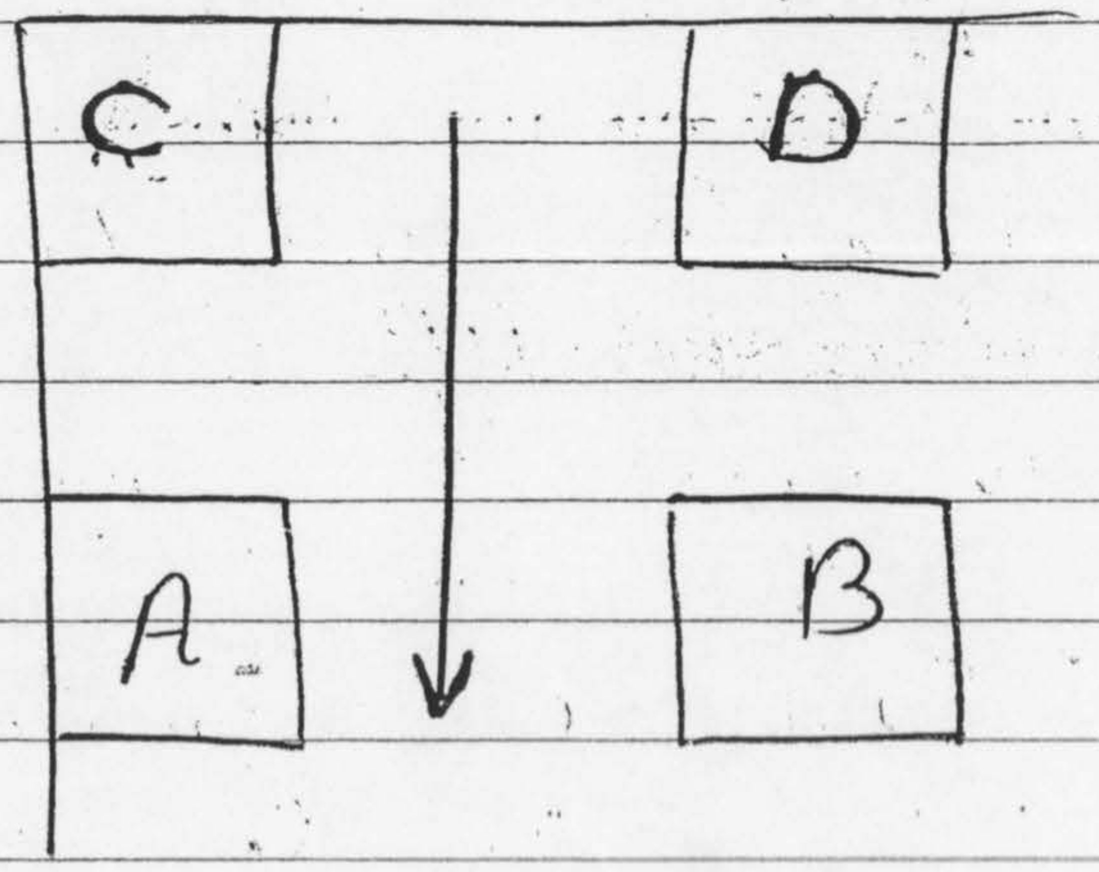
$Mu = 0.26\ M_o$ for bending

$= 0.3\ M_o$ for shear.

$$m_o = \frac{W_u\, l_2\, l_n^2}{8}$$

5'
vP (3) مثال ملزمة

الموضوع :   التاريخ 23/2/2016 ٢٠١ / /



بالنسبة للرسم الاول

تشوف تعرف هو عمودي لو أفقي ، عن طريق Mo

فالـ D والـ C هي اللي بيهم Mo والـ A والـ B

ليهم قانون خاص .

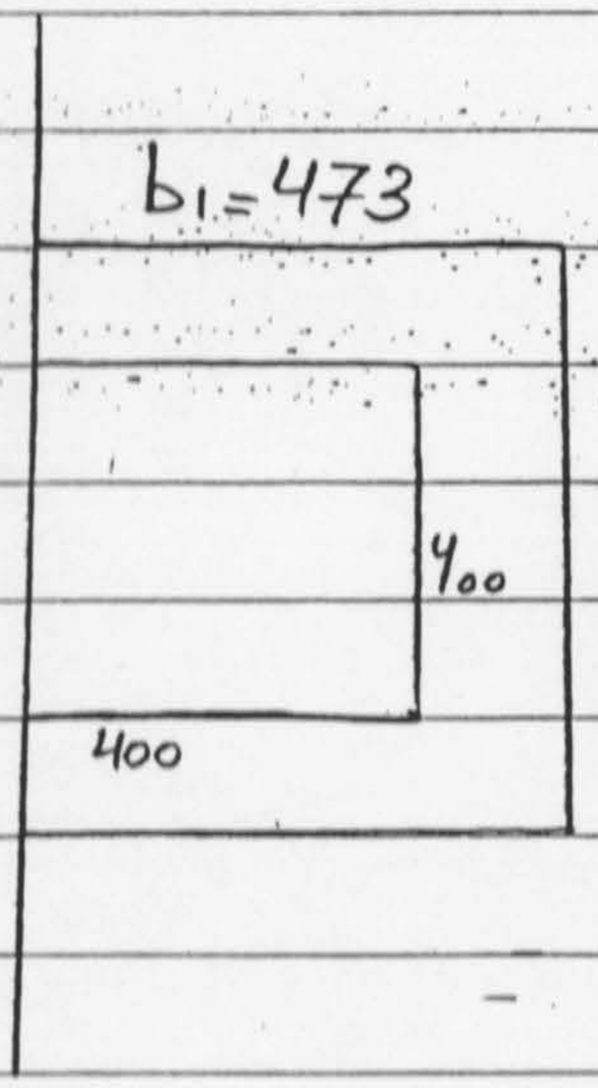
③ الملازمة P.51

Ex: Consider an exterior (edge) panel of a flat plate slab system supported by a 400 mm square Column. Determine shear strength for transfer of direct shear and moment between slab and Column support. Use $f_c' = 28$ MPa, $f_y = 410$ MPa.
Over all slab thickness ($t = 180$ mm), ($d = 146$ mm)

Assume that DDM is used for analysis of the slab. Consider two loading conditions.

① Total factored shear force $V_u = 125$ KN
Total factored static moment (M_o) in the end span = 130 KN.m

② $V_u = 250$ KN, $M_o = 260$ KN.m



قيمة الفصل
$b_o = 473 \times 2 + 546$
$= 1492$ mm

$$V_c = \begin{cases} \text{compute} \\ \text{compute} \\ 0.33\sqrt{f_c}\, b_o d = 0.33\sqrt{28} * 1492 * 146 * 10^{-3} \end{cases}$$

$\therefore V_c = 380.37$ KN

$\phi V_c = 0.75 * 380.37 = 285.3$ KN

$[0.75\,\phi V_c = 0.75 * 285.3 = 214 \text{ KN}]$

Case (1)

$\gamma_f = 1.0$, $\gamma_v = 0$ ⟶ $(V_u < 0.75\,\phi V_c)$

شرط حتى تكون $(\gamma_f = 1, \gamma_v = 0)$

$M_{ub} = M_u * \gamma_f = 1$

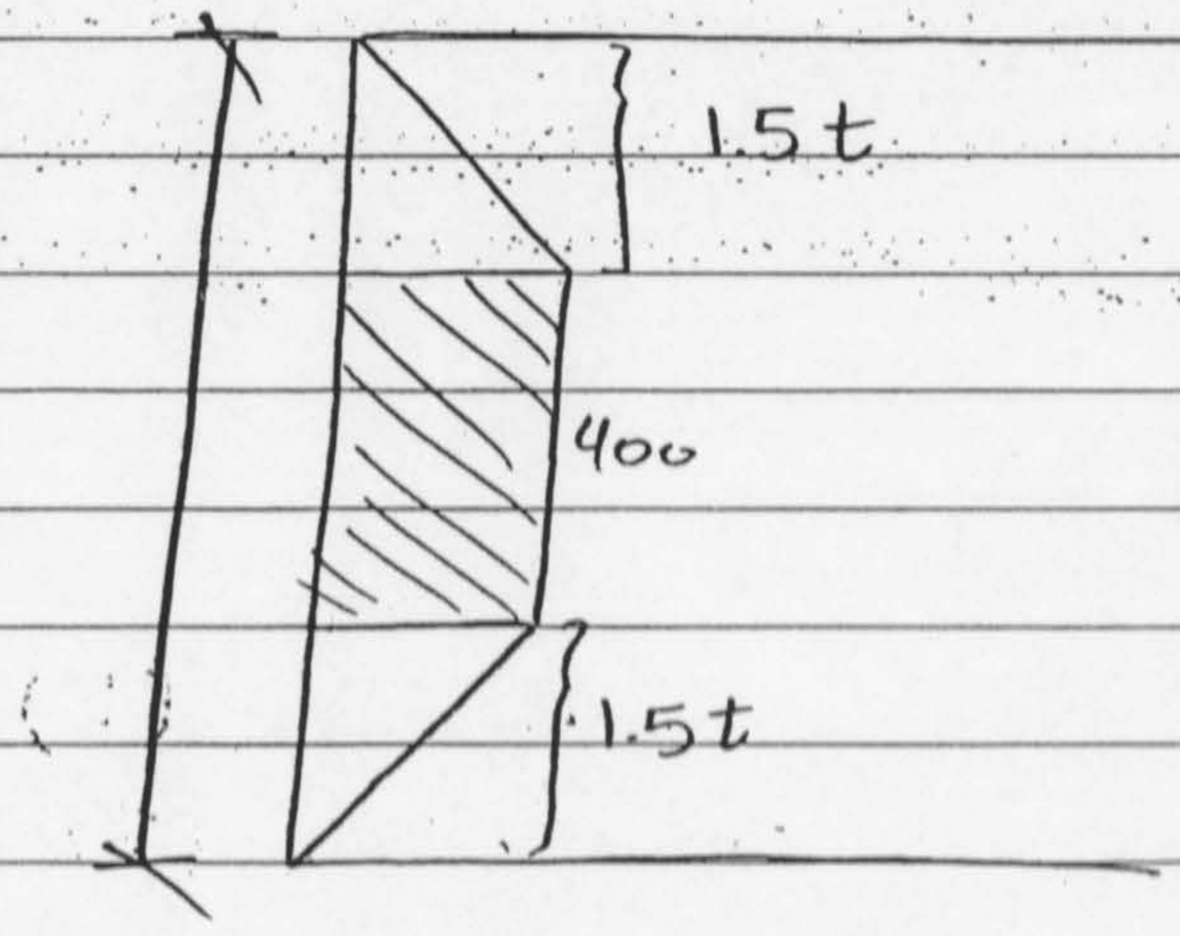
$\therefore M_{ub} = M_u$

$= 0.26\, M_o$ ⟶ for bearing

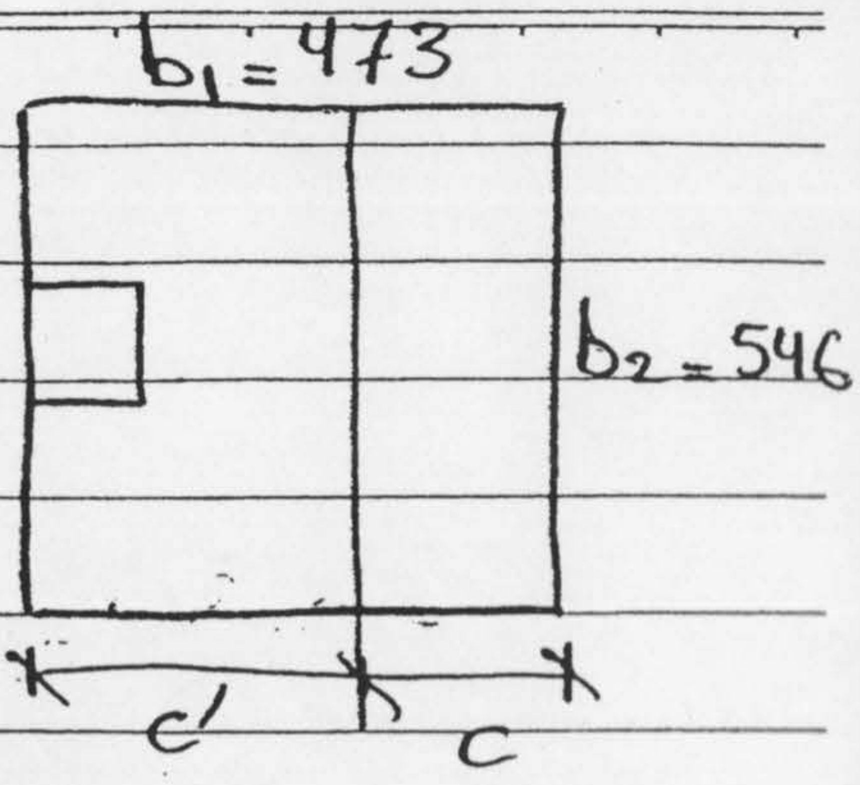
$= 0.26 * 130$

$\therefore M_{ub} = 33.8$

$3 * 180 + 400$
$= 940$



Case (2)



$\therefore V_u > 0.75\ \phi V_c = 214$

$b_1, b_2 = \checkmark$

$C = \dfrac{b_1^2}{2b_1 + b_2} = 149.95$ القانونا من حالة (c) Table P.50

$A_c = (2b_1 + b_2)\, d = 217832$

$\bar{C} = \dfrac{b_1(b_1 + 2b_2)}{2b_1 + b_2} = 323.05$

$\dfrac{J}{c} = \dfrac{b_1^2 d(b_1 + 4b_2) + d^3(b_1 + b_2)}{6\, b_1} = 37661376$

$\dfrac{J}{c'} = \dfrac{J}{c} * \dfrac{c}{c'} = 17481267$

γ_f, γ_v نحسب

$\gamma_f = \dfrac{1}{1 + \frac{2}{3}\sqrt{\frac{b_1}{b_2}}} = 0.62$

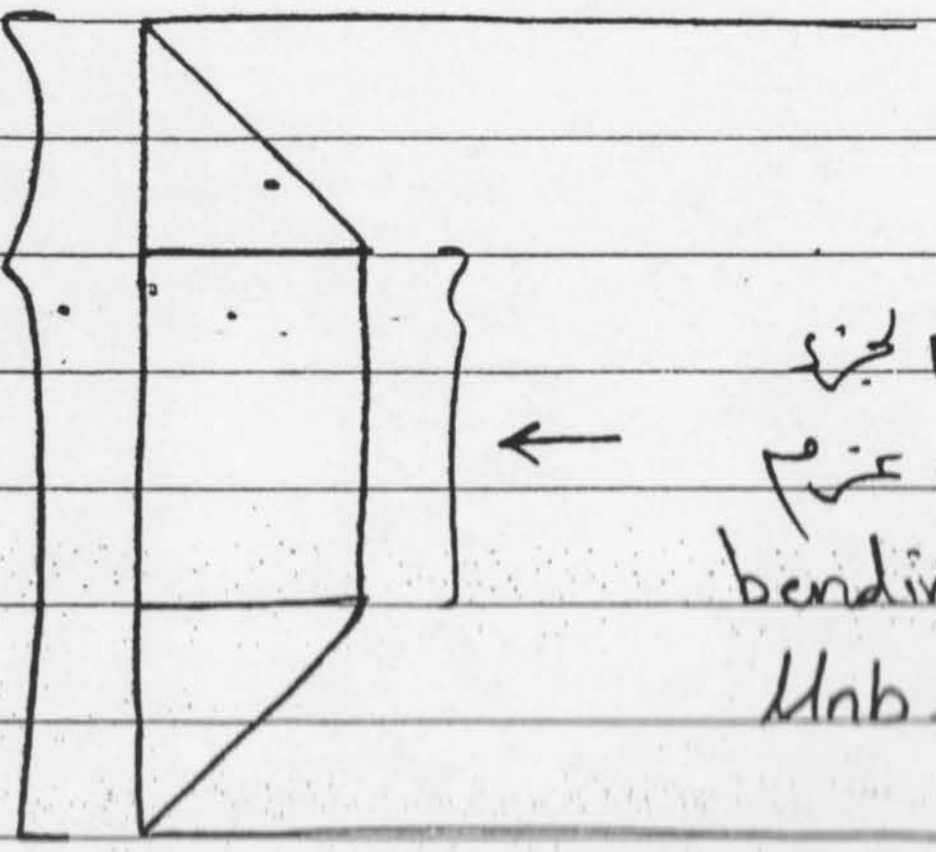
$M_u = 0.26\ m_o$ for bending (b)
$\quad = 0.3\ m_o$ for shear (v.)

$M_{nb} = \gamma_f * M_u$

$= 0.26 * 260 * 0.62 = 41.9$

$M_{nv} = \gamma_v * M_u$

$= 0.3 * 260 * 0.38 = 29.6$



تختلف عن المعطاة بالسؤال

$V_{u1} = \frac{V_u}{A_c} + M_{nv} * \frac{C}{J_c}$

تحويل ل KN.m N.mm

تحويل KN ل N

$= \frac{250 * 10^3}{217832} + \frac{29.6 * 10^6}{37661376} = 1.148 + 0.786$

$= 1.934\ N/m^2$ (MPa)

$\phi V_c = 0.75 * 0.33 * \sqrt{f_c} = 1.309\ KN$

$\therefore V_{u1} > \phi V_c$

∴ نحتاج حديد تسليح

$\phi * 0.5 * \sqrt{fc} = 1.984$

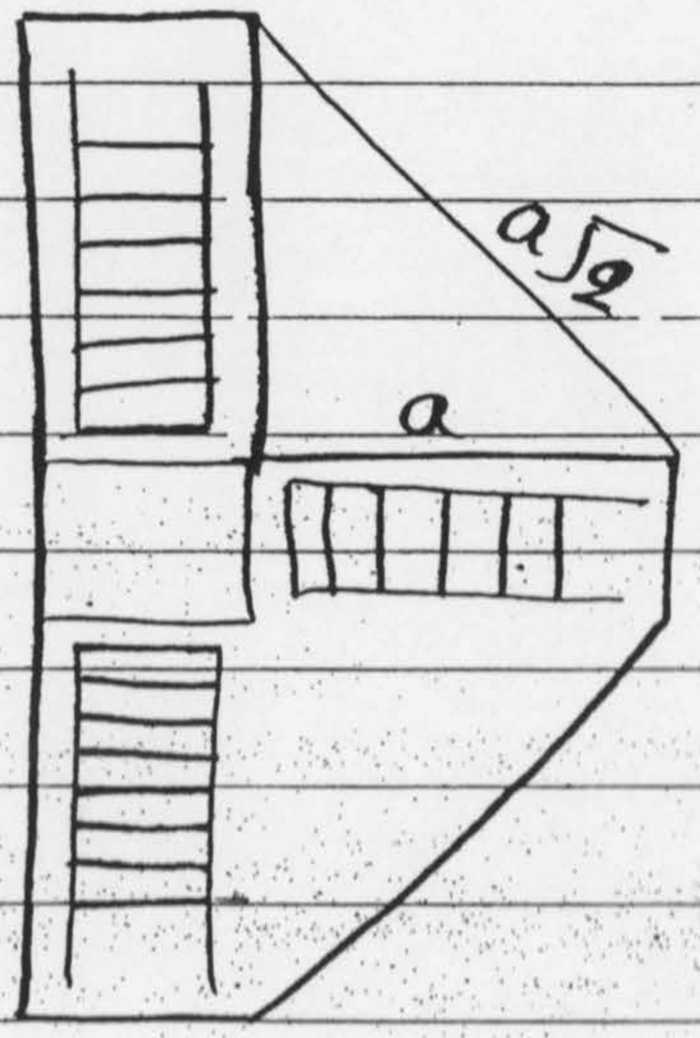
if $V_{u_1} > \phi V_c$

: تحتاج نكبر الـ thickness

بس هنا طلعت أصغر

$S = \frac{d}{2} = \frac{146}{2} = 73 \simeq 70$

نأخذ قيمة قريبة أقل



$$Av = \frac{(V_{u_1} - \phi V_c) S * b_o}{\phi f_y}$$

$= 428$

الحديد بـ ٣ جهات وكل جهة لها اتجاهات فلازم نقسم على 6 اتجاه حتى نجد عدد البارات.

no. of Stirrups $= \frac{428}{6} = 71.3 \simeq 78$

أقرب standared بحيث bar $\phi 10$

$Vu = \phi\, 0.17 \sqrt{fc}\; b_o d$

$250 = 0.75 * 0.17 * \sqrt{28} * (400 * 3 + 2a\sqrt{2}) * 146$

$\therefore a = 473.1$

no. of Spacing $= (a - \frac{d}{2}) / 70 = 5.7 \simeq 6$

using $\phi 10$ @ 6m

Reinforcement details

Case (1)

(A) Reinforcement of column strip :

$M_o = 130$
M - exterior $= 0.28 * 130 = 33.8$

$M.c.s = 33.8$
$M m.s = 0$ } ال C.S ياخد كل القيمة لان ال β كلش كبيرة

$M = 33.8$, $M_n = \frac{33.8}{0.9} = 37.56$

$b = 2250$, $d = 146$
كل جهة نأخذ الاصغر ونقسمه على (2)

As required of c-s $= \left[\frac{1 - \sqrt{F - \frac{2.236 M_n}{f_c \, b \, d^2}}}{1.18} * \frac{f_c}{f_y} \right] * b \, d$

$= 638 \ mm^2$

Winner Line

$As_{min} = 0.0018\ bt = 0.0018 * 2250 * 180 = 729$

$\therefore$ use $As_{min} = 729$

$S = 2250 * \frac{Abar}{A\ total} = 2250 * \frac{122.7}{729}$

$= 378.7 > S_{max} = 2t = 360$

$\therefore$ Use $\phi 12$ @300 in Column Strip.

(B) Reinforcement of effective width

$Mub = 33.8$

$Mn = 37.56$ نفسة بالفترة السابقة , $b = 940$, $d = 146$

$As_{\text{required for effective}} = 654.92$

$Asmin = 0.0018 * 940 * 180 = 304.56$

$\text{no. of bars} = \frac{\text{total area}}{\text{area of bar}} = \frac{654.92}{122.7} = 5.3 \simeq 6$

للاطلاع $\therefore$

حتى نحمل على $\delta f = 1$, $\delta v = 0$ لازم نحقق شرطين

$\varepsilon s \geq 0.004$ $Vu \leq \phi 0.75\ Vc$

$0.75 * 0.75 * 0.033 * \sqrt{fc} * bod$

$a = \frac{As\ fy}{0.85 * fc' * b} = \frac{122.7 * 6 * 410}{0.85 * 28 * 940} = 13.49$

$c = a/\beta = 13.49/0.85 = 15.875$

$\varepsilon t = \varepsilon s = [d - c/c] * 0.003 = 0.0245 > 0.004$

Case (2)

$V_u = 250$, $M_o = 260$

(A) Reinforcement of C.S., M.S

$M_{E.N} = 0.26 * M_o$
$= 67.6$

$M_{cs} \simeq 100\% = 67.6$

$M_{ms} = 0$

2250 → Case (1) من B ال.

2250 use $A_{s\,min} = \phi 12$ @ 300 mm
$A_{s\,min} = 0.0018\ b\ h$
↓ thickness

$$A_{s\ required\ of\ C.S} = \left[\frac{1 - \sqrt{1 - \frac{2.36 * M_n}{f_c\, b d^2}}}{1.18} * \frac{f_c}{f_y} * b * d \right]$$

$Mn = \frac{67.6}{0.9}$, b = 2250 , d = 146

∴ As required of C.S = 820.5

As min = 0.0018 b h , b = 2250 , h = 180
As min = 729

∴ **Use As = 820**

$S = b * \frac{A_{sb}}{A_{s total}}$ (use φ12 mm)

$= 2250 * \frac{122.7}{820}$

= 336.7 > Smax = 2h = 360

∴ **Use φ12 @ 300**

(B) Reinforcement of effective width

Mub = 0.62 * 0.26 * 620
= 41.91

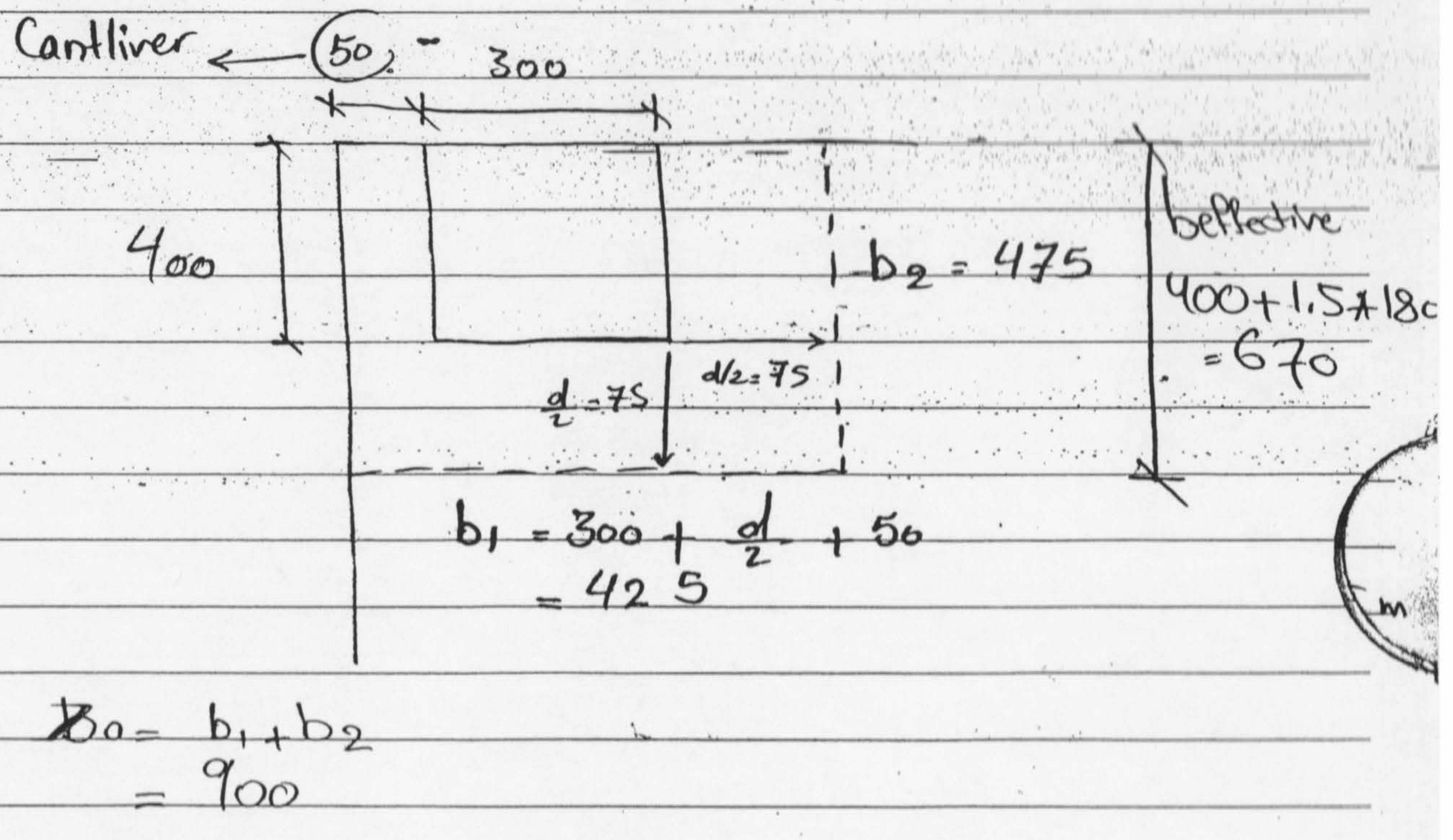
$M_n = \frac{41.91}{0.9}$, $b = 940$, $d = 146$

As required = 816   كمية حديد التسليح

As min = 304.56

no. of bars = $\frac{816}{122.7} = 6.7 \simeq 7$

Ex: $d = 150$, $f_c = 28$, $f_y = 410$
$M_o = 120$, $V_u = 150$, corner column



$b_1 = 300 + \frac{d}{2} + 50$
$= 425$

$b_o = b_1 + b_2$
$= 900$

$V_c = 0.5 * 0.75 * 0.33 * \sqrt{f_c} * b_o d * 10^{-3}$
$= 88.4$

$V_u > \phi V_c$
$150 > 0.75 * 88.4 = 66.3$

هسه نشتغل حسابات ال moment transfer الريتابية.

$\gamma f = 0.61$
$\gamma v = 1 - \gamma f = 0.39$

<u>Shear</u>
$A_c = (b_1 + b_2) d$ ⟶ هنا الجدول حسب الحالة D
$A_c = 135000$

$J_c/c = 25894301.47$ هنا الجدول ناخذ قانون (C) حسب الرسم P.50

$$V_{u1} = \frac{V_u}{A_c} + M_{uv} \frac{c}{J_c}$$

$M_{uv} = \gamma v * M_{uv}$
$= 0.39 * 0.3 * 120$
$= 14.04$

$$V_{u1} = \frac{150 * 10^3}{135000} + \frac{14.04 * 10^6}{25894301.47}$$ (10^6) ⟶ للتحويل

Winner Line

$V_{u1} = 1.111 + 0.5376$
$= 1.64876$

$V_c = 0.75 * 0.33 * \sqrt{f_c}$
$= 1.31$

$V_{u1} > V_c$

∴ need reinforcement

$V_{max} = 0.75 * 0.5 * \sqrt{f_c}$
$= 1.95$

$V_{u1} < V_{max}$

∴ نحتاج حديد تسليح

لو كانت $V_{u1} > V_{max}$ نحتاج نزيد السمك.

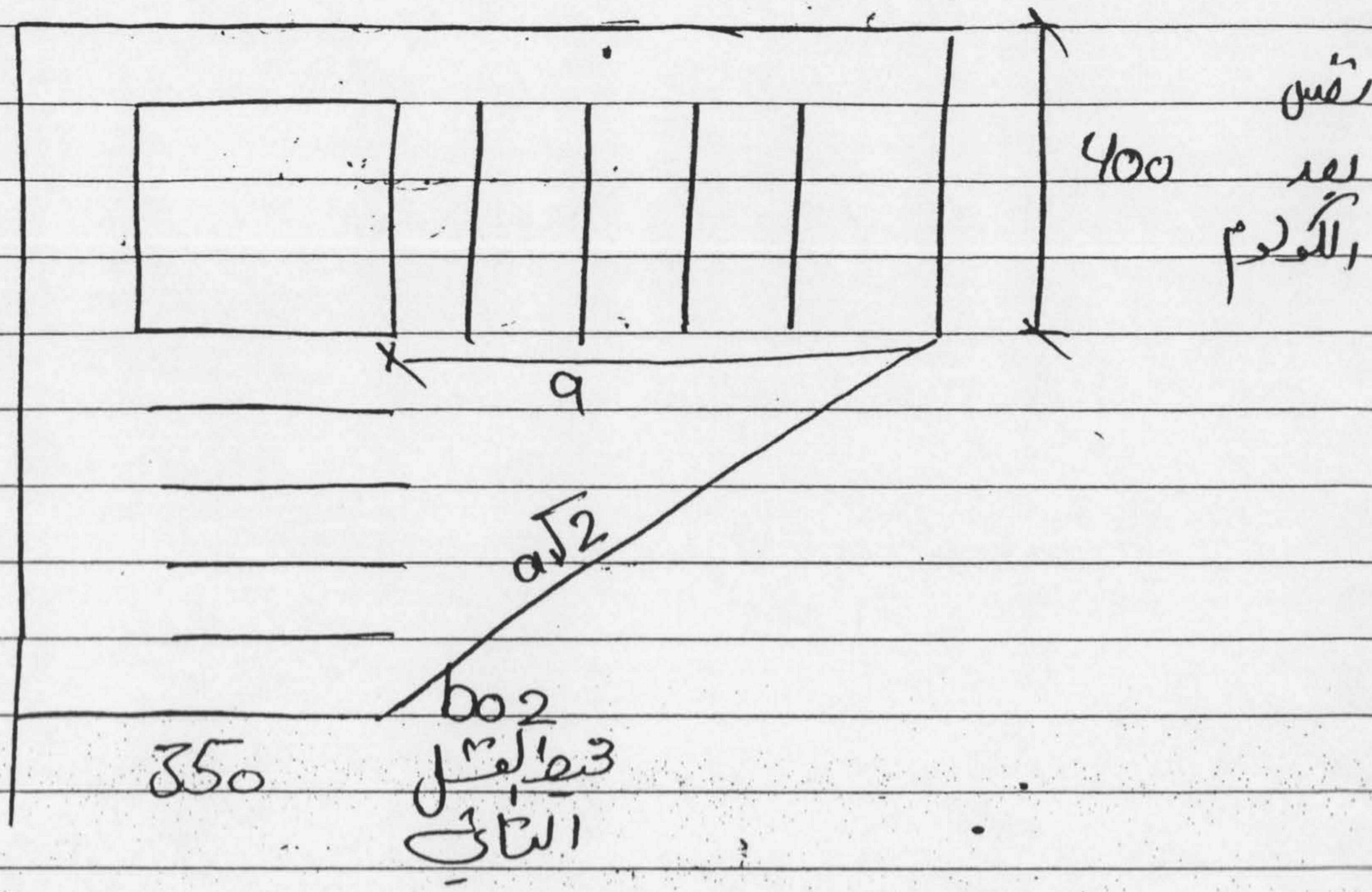
$S = \frac{A_v \phi f_y}{(V_{u1} - \phi V_c) b_o}$

و جهتين لكل جهة
2*2=4

$= \frac{(78 * (4)) * 0.75 * 410}{(1.64876 - 0.75 * 0.17 * \sqrt{28}) * 900}$

$= 109.5 > S_{max} = \frac{d}{2} = \frac{150}{2} = 75$

∴ Use $S = 75$



$$V_u = 0.75 * 0.17 * \sqrt{f_c} * b_{o2} * d$$

$$b_{o2} = \frac{150 * 10^3}{0.75 * 0.17 * \sqrt{28} * 150}$$

$$= 1482$$

$$b_{o2} = a\sqrt{2} + 400 + 350 = 1482$$

$$\therefore a = \frac{1482 - 750}{\sqrt{2}} = 517$$

Winner Line

no. of. Spacing $= \frac{(a - \frac{d}{2})}{S}$

$= \frac{517 - 75}{75}$

$= 5.9$

∴ Use 6 bars

Reinforcement

$M_{ub} = 0.26 * 160 * 0.61 = 19$

effective width $= 400 + 1.5 * 180 = 670$

$A_s = 356$
$M_n = 19 / 0.9 = 21.11$
$b = 670$
$d = 150$

$A_{s\,min} = 217$
$A_s = 356$

no. of bars $= \frac{356}{122.7} = 2.9$

∴ Use 3bars Φ12

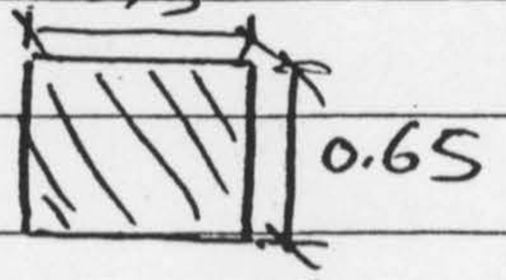
Transfer of moment
Interior column B

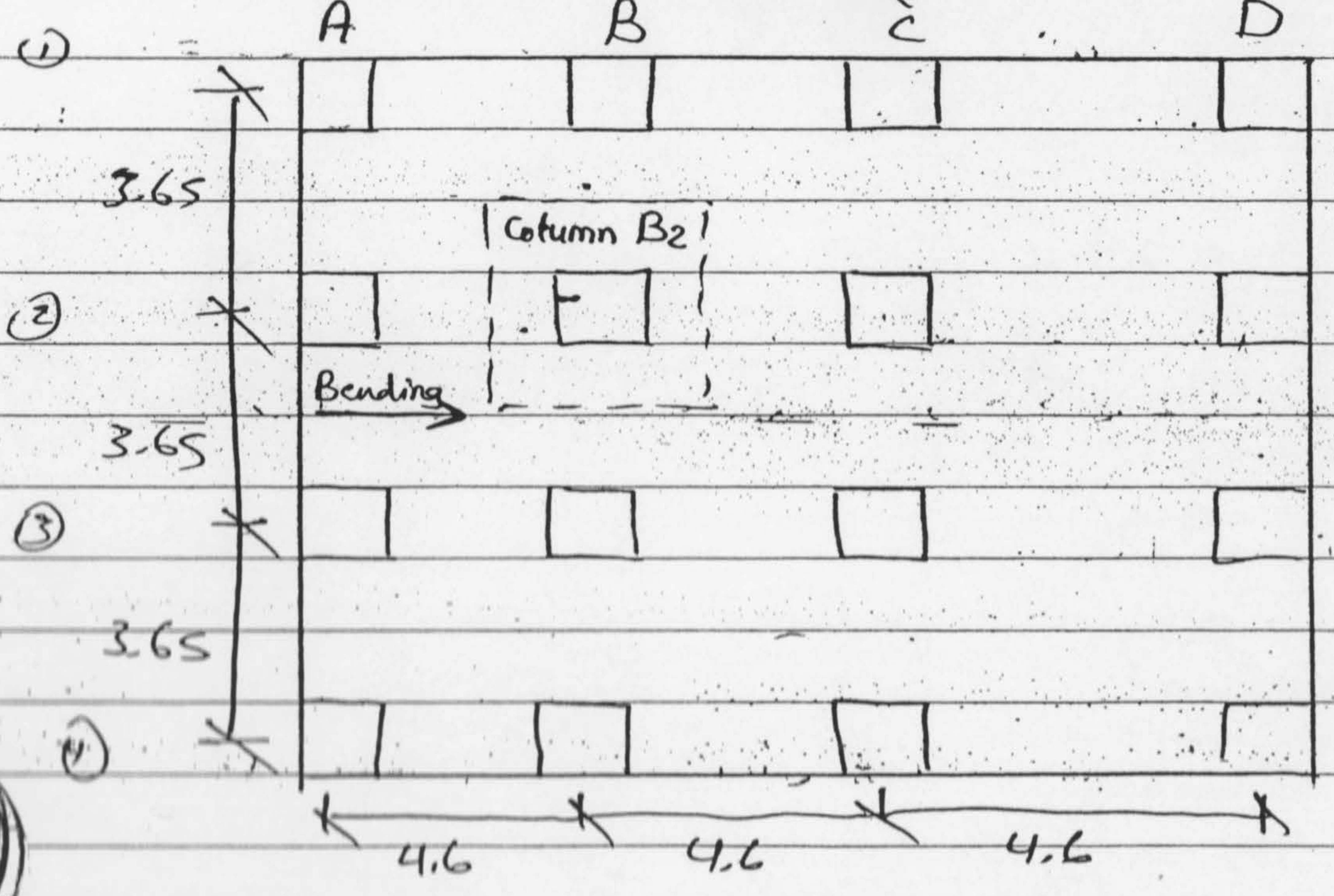
Ex: $W_{Du} = 4.7$, $W_{Lu} = 5.1$, $W_u = 9.5$

$t = 140$, $d = 10.8$, $F_c = 25$, $F_y = 410$

$V_u = 165$ (تعطى او تحسب من المقارنة)

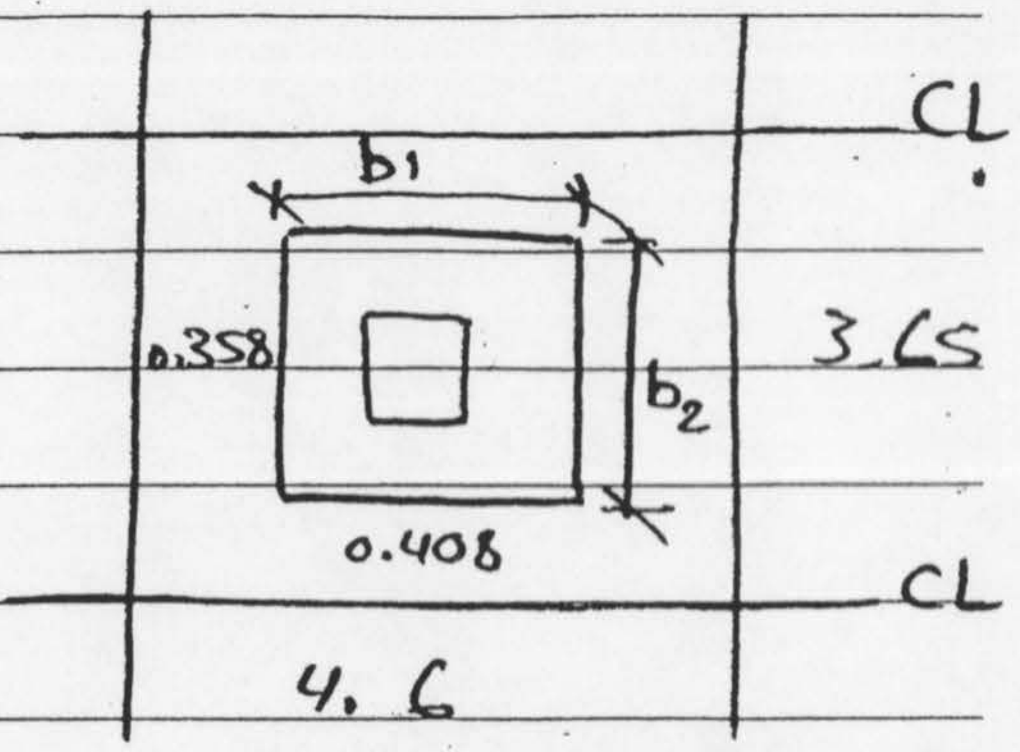
All Column





$Vu = 165$ (تعوض)
أو تحسب كالتالي

$Vu = 9.8 * [4.6 * 3.65 - 0.358 * 0.408]$



(Mu) تعوض أو تحسب كالتالي

$Mu = 0.07 [(WD * L_2 Ln^2 + 0.5 WL * L_2 Ln^2)] - wd' L_2' Ln'^2$

الهم نفس الابعاد

$= 0.07 * 0.5\ WL * L_2\ Ln^2$
$= 0.07 * 0.5 * 5.1 * 3.65 * 4.3 = 12\ KN.m$

$b_1 = 408,\ b_2 = 358$
$bo = (408 + 358) * 2 = 1532\ mm$

$\phi Vc = 0.75 * 0.33 * \sqrt{28} * 1532 * 108 * 10^{-3}$
$\phi Vc = 216.6$

$$\gamma f = \frac{1.25}{1 + \frac{2}{3}\sqrt{\frac{b_1}{b_2}}} \leq 1.0$$

حتى نستخدم هذا القانون لازم يتحقق شرطين
ونستخدم هذان الشرطان في حالة (interior , Edge)

$V_u < \phi V_c$

$165 > 86.6$

$\varepsilon_s > 0.01$

الشرط الاول لم يتحقق فنستخدم المعادلة الاعتيادية

$\gamma_f = \frac{1}{1+\frac{2}{3}\sqrt{\frac{b_1}{b_2}}} = 0.584$

$\gamma_v = 1 - \gamma_f = 0.416$

$M_{ub} = M_u * \gamma_f$

$M_{ub} = 12 * 0.584 = 7.01$

$M_{uv} = M_u * \gamma_v$

$= 12 * 0.416 = 4.99$

$A_c = b_o * d = 1532 * 108 = 165.456 * 10^3 \ mm^2$

J_c/c from table [case B]

$J_c/c = 22.2 * 10^6$

يختلف عن المعادلة بالسؤال

$V_u = \frac{V_u}{A_c} + \frac{M_{uv} c}{J_c}$

$= \frac{165 * 10^3}{165.456 * 10^3} + \frac{4.99 * 10^6}{22.2 * 10^6} = 0.997 + 0.225$

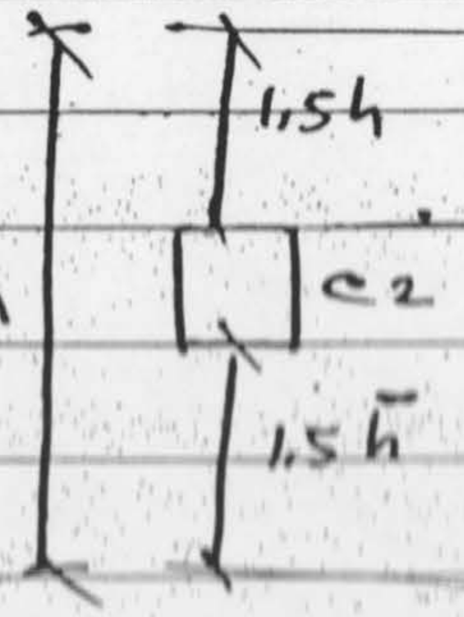
$= 1.22$

نقارن الـ Vu الجديدة مع ϕV_c عشان
نعرف نحتاج تسليح أو لا.

V_u ϕV_c

$1.22 < 0.75 * 0.33 * \sqrt{25}$
$= 1.309$

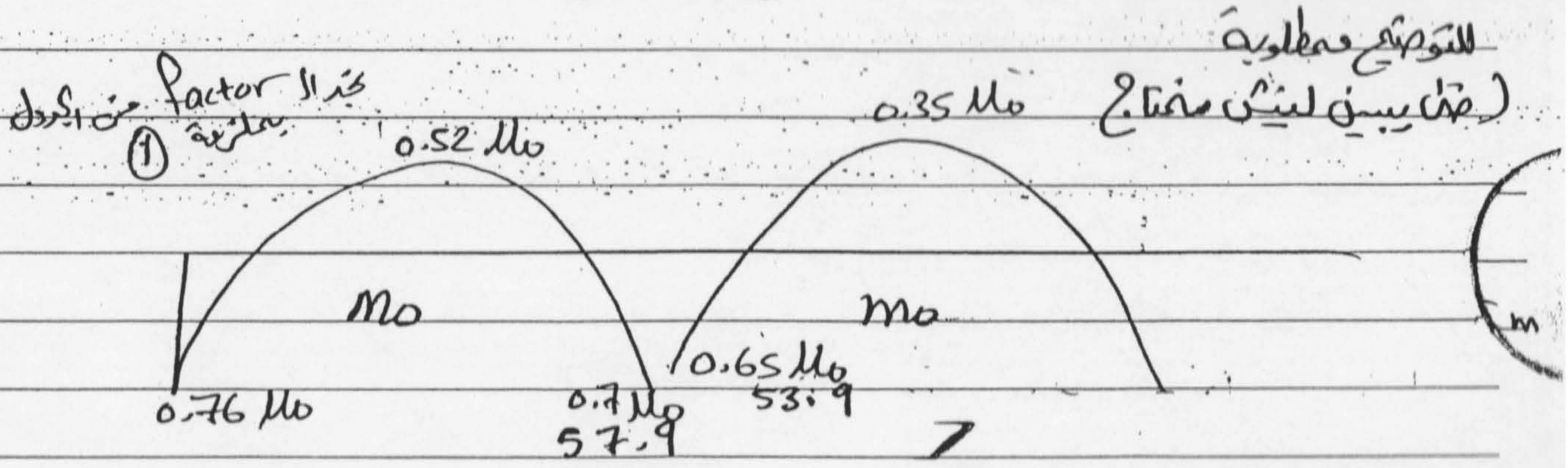
$\therefore V_u < \phi V$ ∴ محتاج حديد تسليح



<u>Bending:</u>

$M_{ub} = 7.01$

width effective $= C_2 + 3h$
$= 250 + 3 * 140$
$= 670$



$m_o = \frac{9.8 * 3.65 * 4.3^2}{8} = 82.7$ KN.m

من الجدول بطريقة ①

$\alpha \; \frac{l_2}{l_1} = 0$

$M_{cs} = 57.9 * 0.75$
$= 43.4$

width C.S = 1.825 m

عرض الكولوم ستريب

$M = \frac{M_{c.s}}{width\,C.S} = \frac{43.4}{1.825} = 23.7$ KN.m

$M = 23.7 * 0.67$
$= 15.87$

$> M_{b.} = 7.01$

Mbalance تسليح يكون بقادم ا هرنت الخارجي محتاج تسليح

∴ no need for addition reinf.

★ في حال يكون محتاج مدير تسليح نحل بالتالي

Reinforcement of C.S

$M = 43.4$, $b = 1825$, $d = 108$

$A_s = 1168$ mm^2
$A_{s\,min} = 453.8$ mm^2

$S = 1825 * \frac{A_b}{A_{total}}$

$S = 1825 \times \frac{122.7}{1167} = 192 \text{ mm}$

$\simeq 190 < S_{max} = 2t = 280$

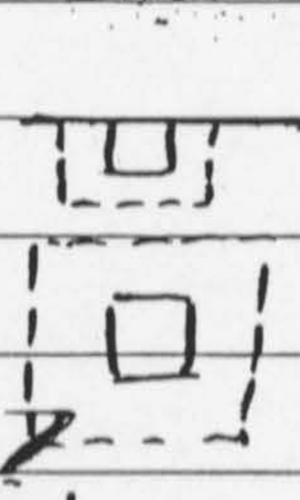
∴ Use $\phi 12$ @ 190 mm

$M = 7.01$, $b = 670$, $d = 108$

$A_s = 179$ < 3 Ab
$A_{s\,min} =$ 368.1

$\frac{670}{140}$ نقسم نحتاج Bar حتى نعرف كم

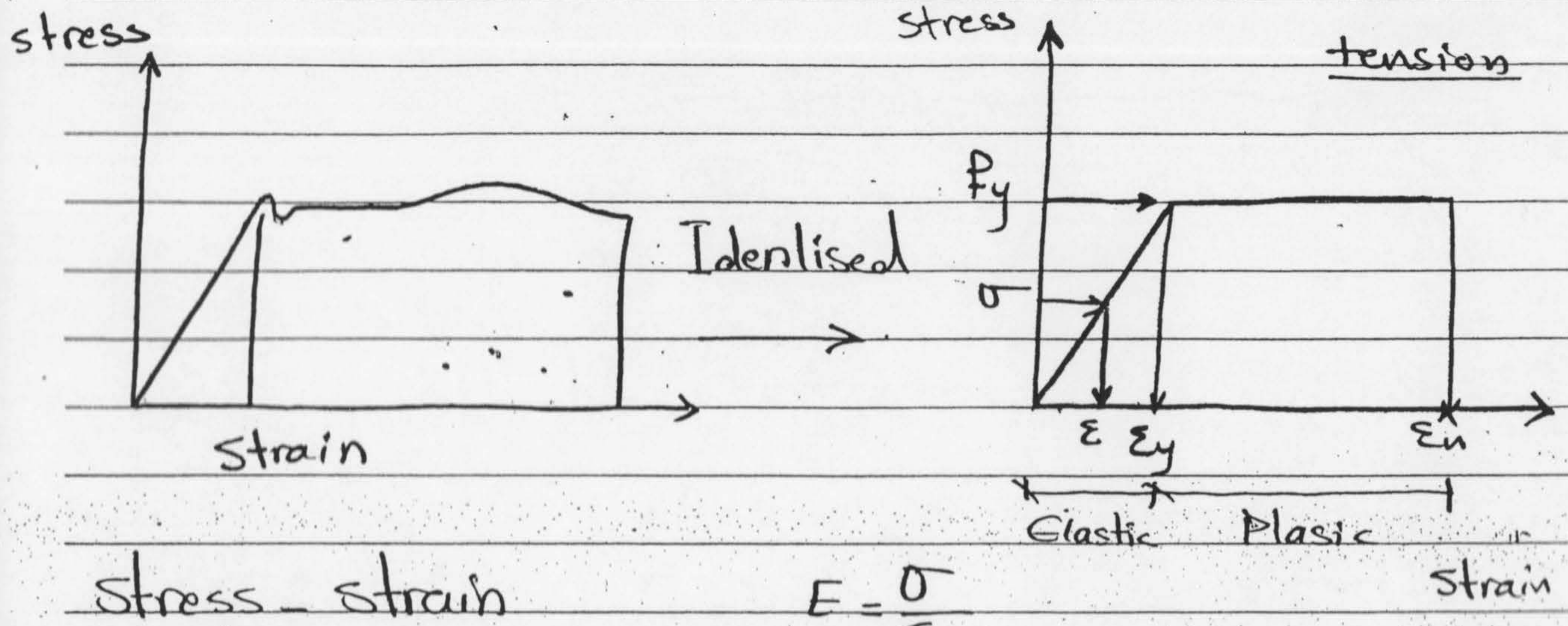
not need for reinforcement



Note: حالة B (interior)
حالة A (edge)

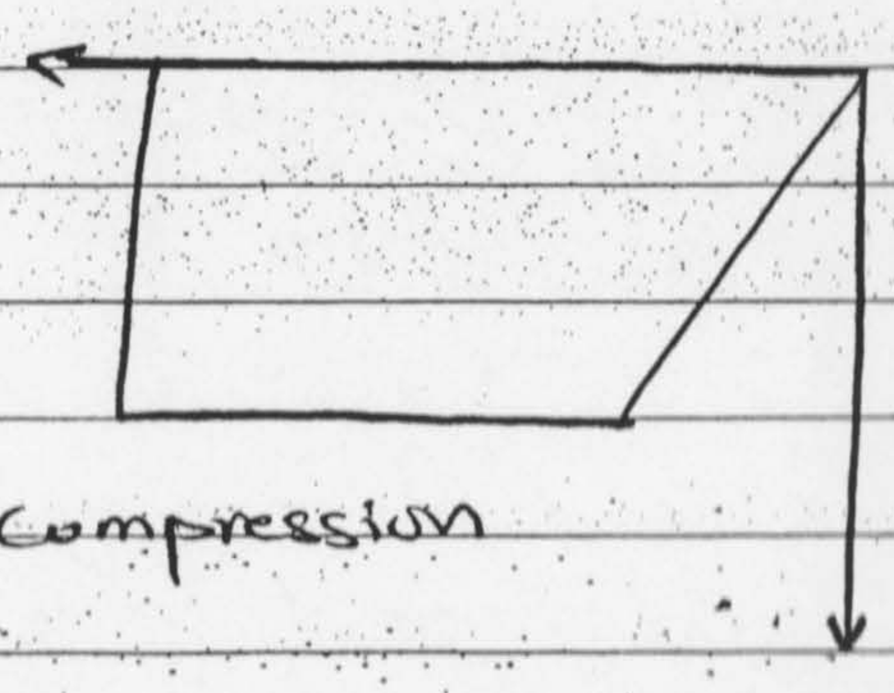
فقط في الموقت يمين الـ L_2 تختلف

"Yield Line Theory"



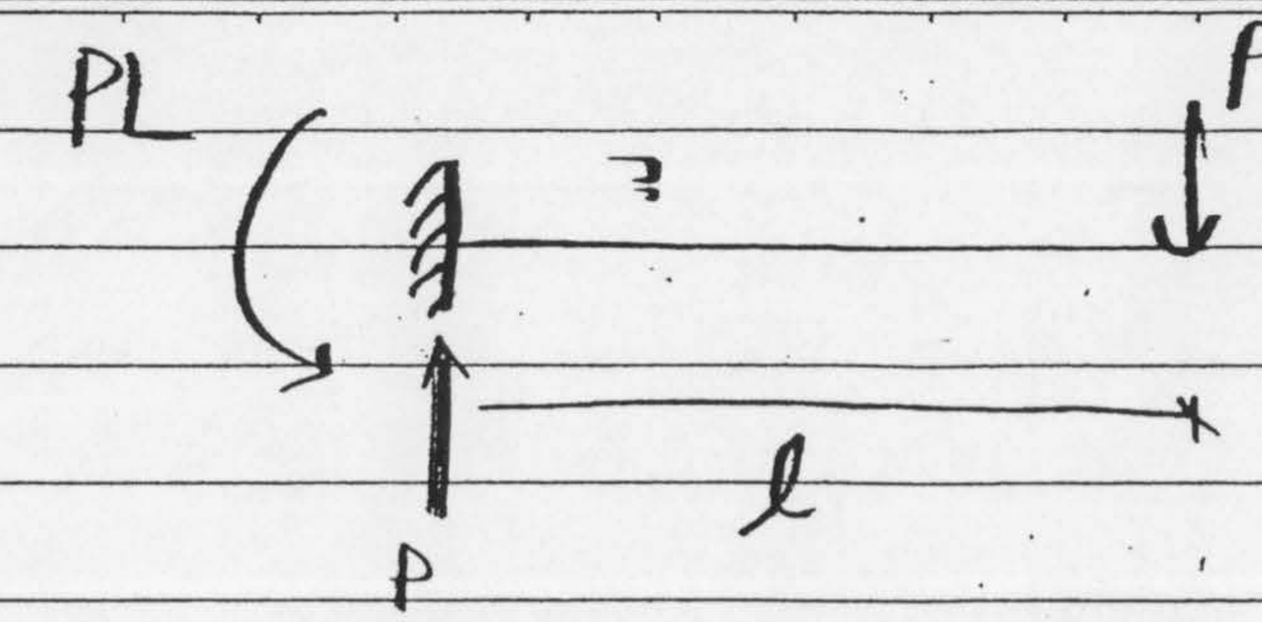
Stress _ strain
Steel

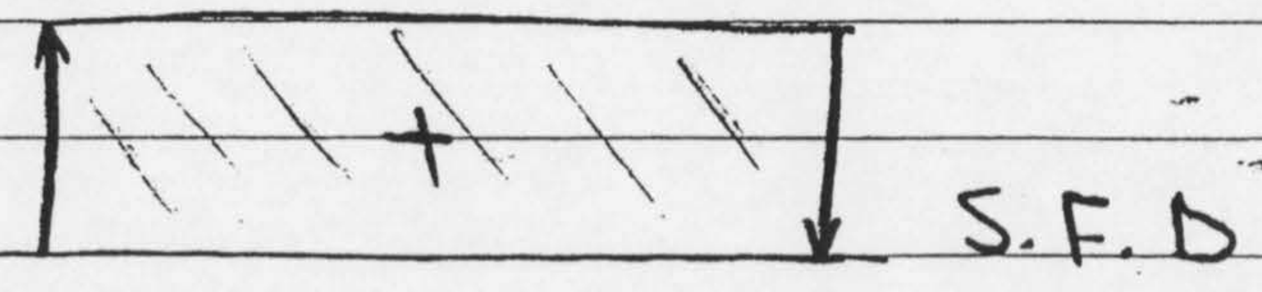
$E = \frac{\sigma}{\epsilon}$

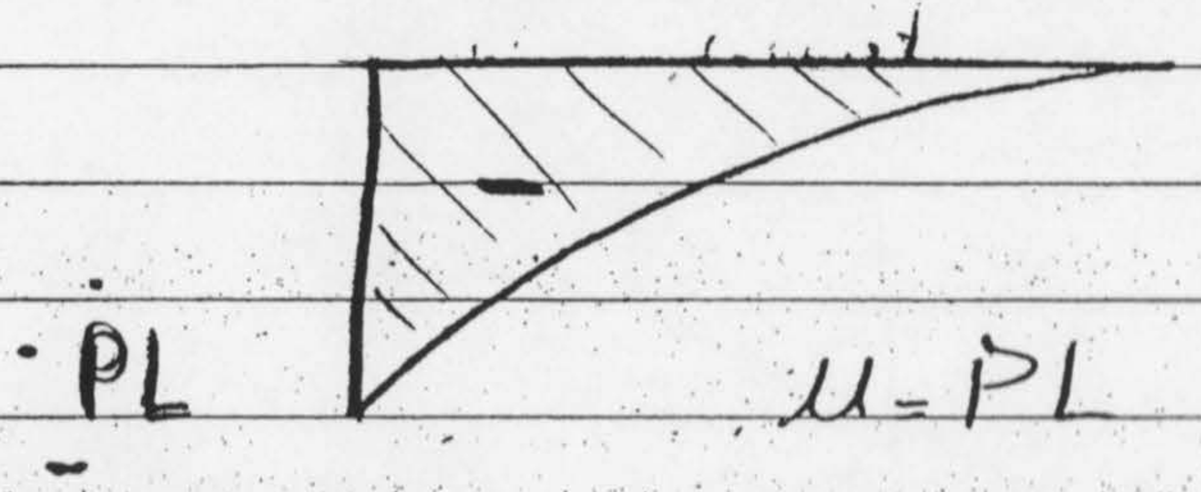


إلحمدُ -- إن الله بك وبقلبك عليم رحيم ---- ♥

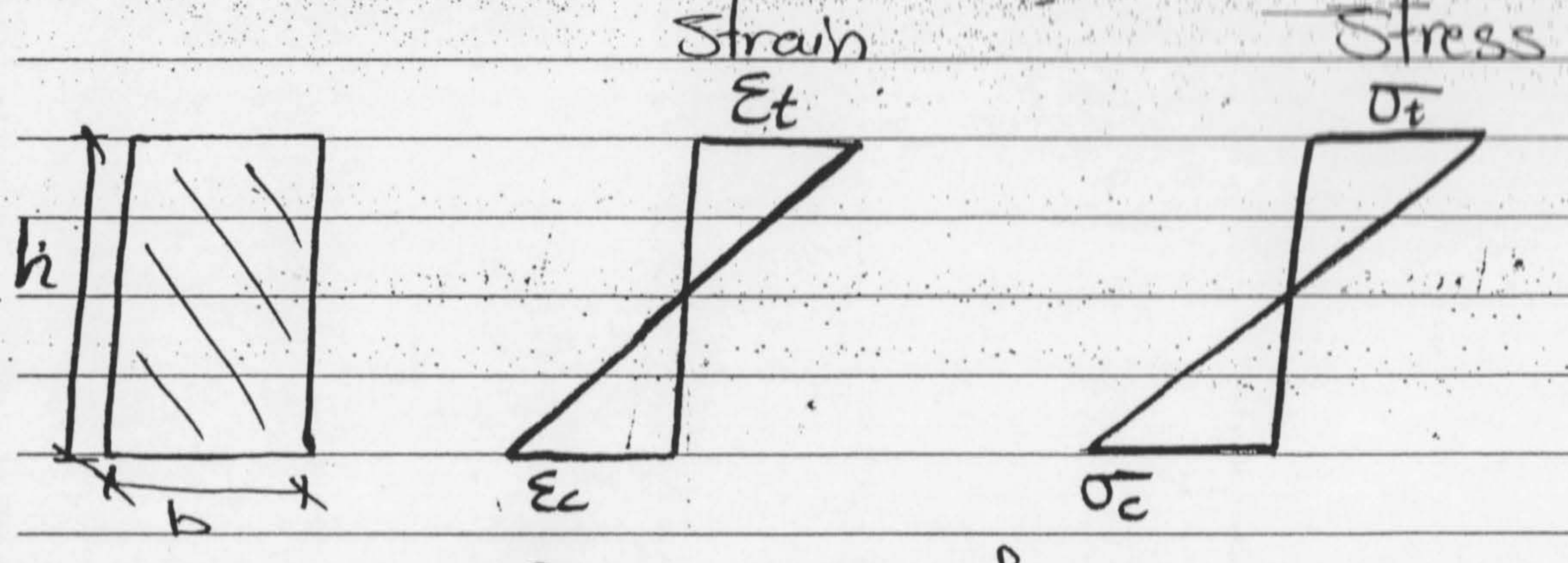
الموضوع : التاريخ / / ٢٠٠

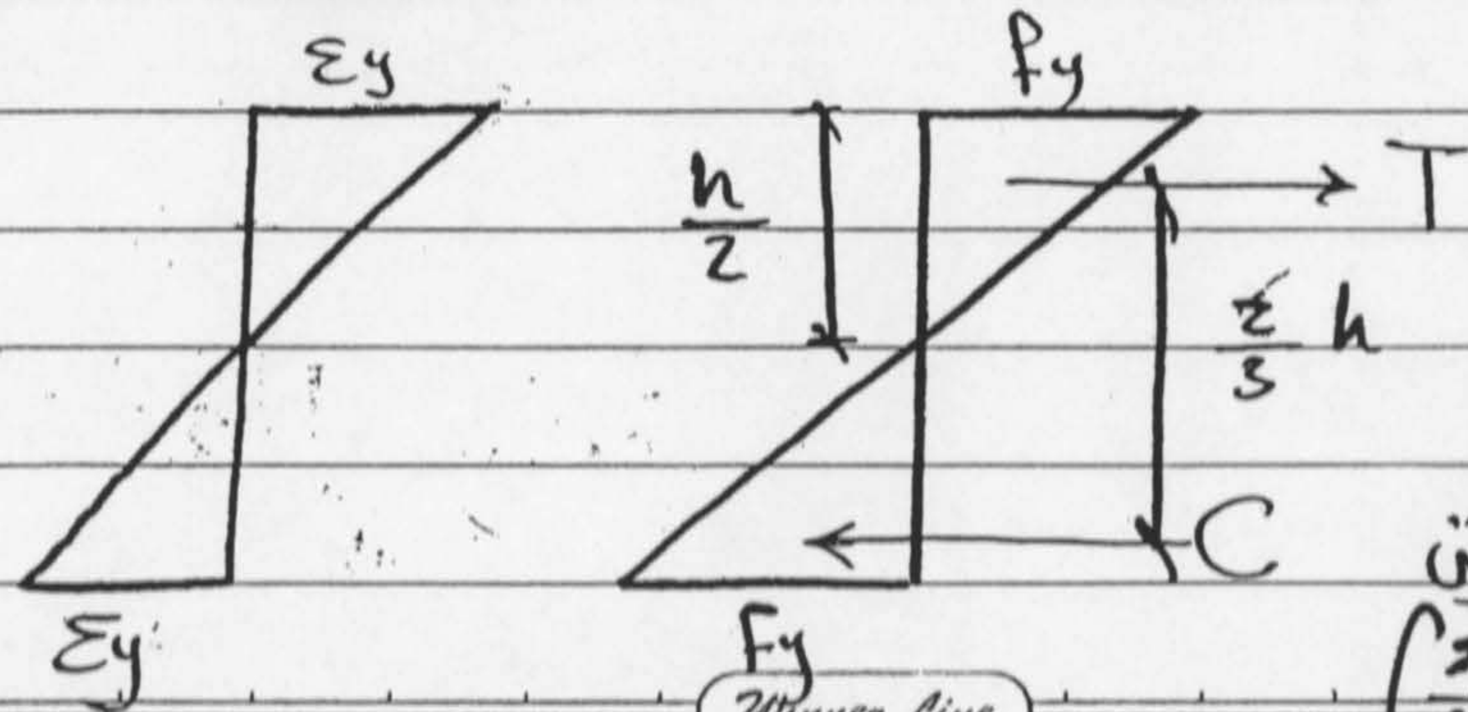






نبدي بزيادة ال P تدريجياً





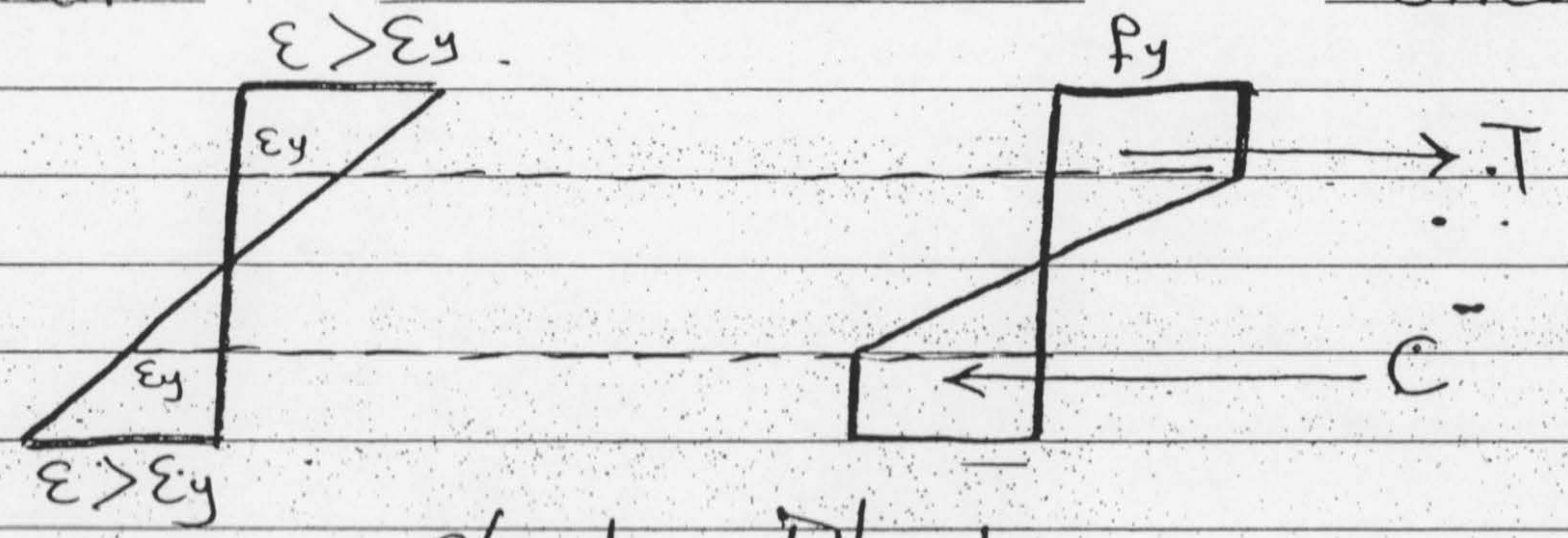
بالمثلث ال T مسافة عن القاعدة $\frac{1}{3}$ وال C كذلك نجمع المسافتين فتكون المسافة بينهم $\left(\frac{2}{3}h\right)$

لنجد ال M التي بالرسم ، لاحظ ان قيمة
ال C وال T تشتغل ك couple وان قيمة ال T
وال C هي عبارة عن مساحة مثلث وذراعهم هي
حسب المعادلة التالية :

$$M_e = f_y \cdot \underbrace{\frac{h}{2} \cdot \frac{1}{2} b}_{\text{مساحة مثلث}} \cdot \underbrace{\frac{2}{3} h}_{\text{الذراع بين ال couple}}$$

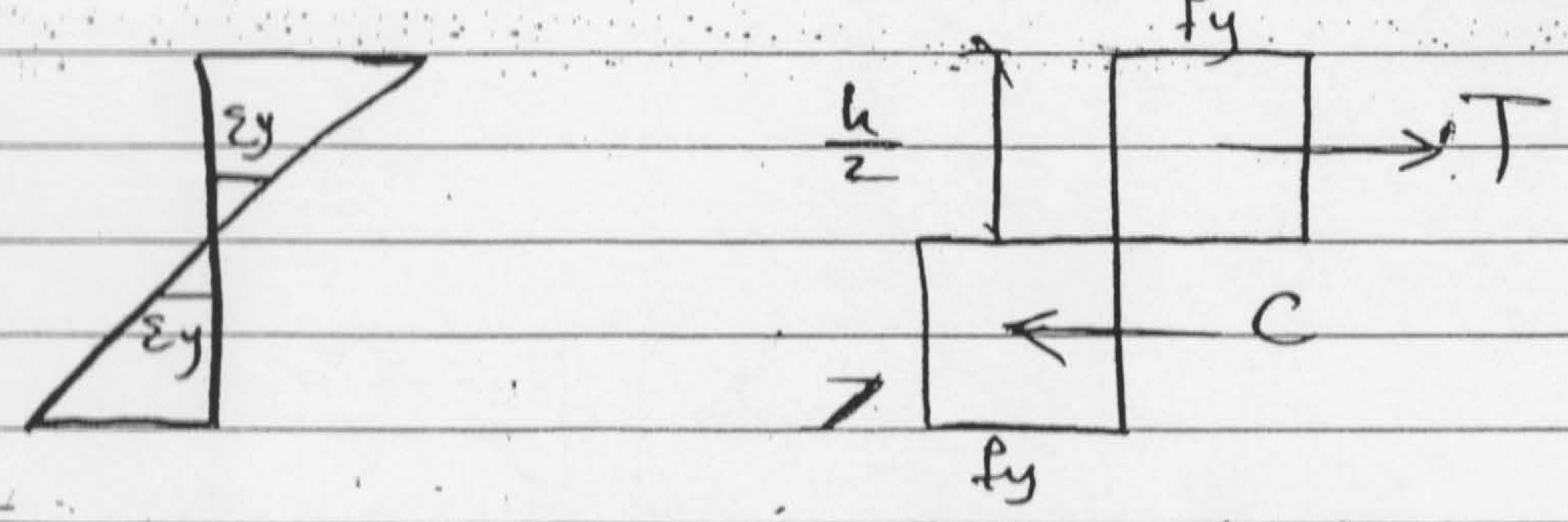
$$\boxed{M_{e\,\text{elastic}} = f_y \frac{bh^2}{6}}$$

Strain — Stress



Elastic_Plastic

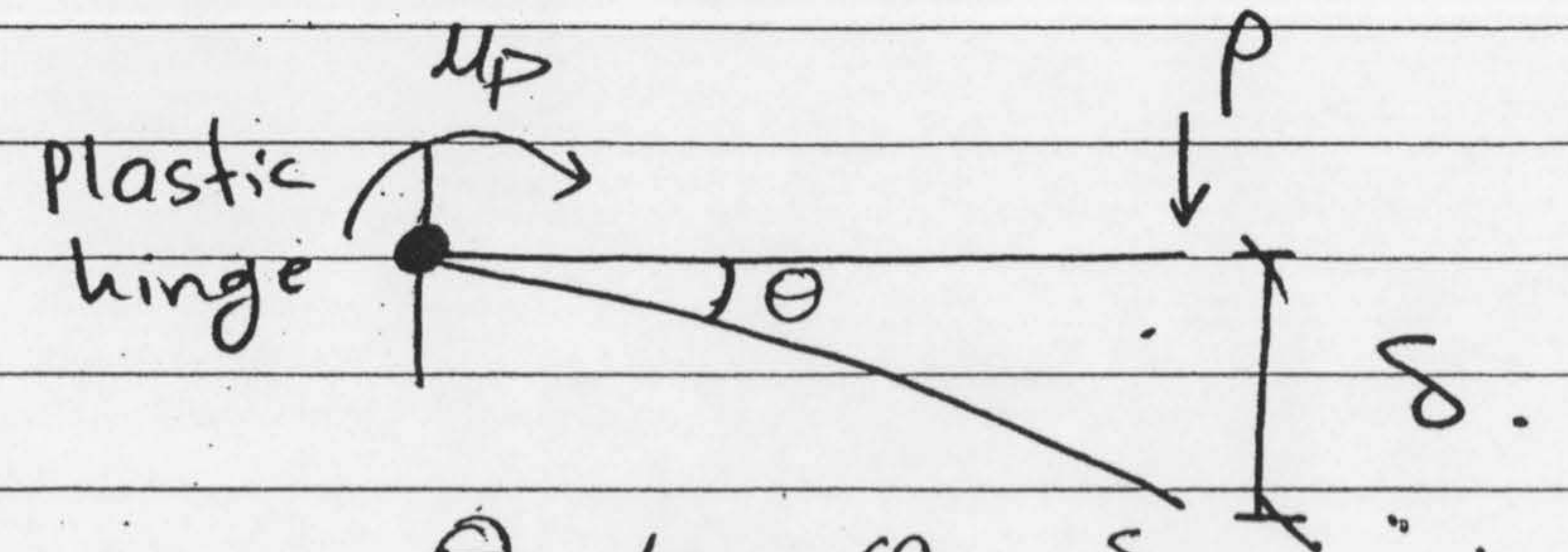
Strain — Stress



fully Plastic

$$M_{p\ (plastic)} = F_y \cdot \frac{h}{2} \cdot b \cdot \frac{h}{2} = F_y \frac{bh^2}{4}$$

$$\boxed{M_p = 1.5\ M_e}$$



* بعد تحول شكل الـ fully Plast. يتحول الـ fixed الى hinge

* Plastic hinge موضع اعتيادي معه عزم Plastic

$$\theta = \tan\theta = \frac{\delta}{L}$$

Plastic analysis

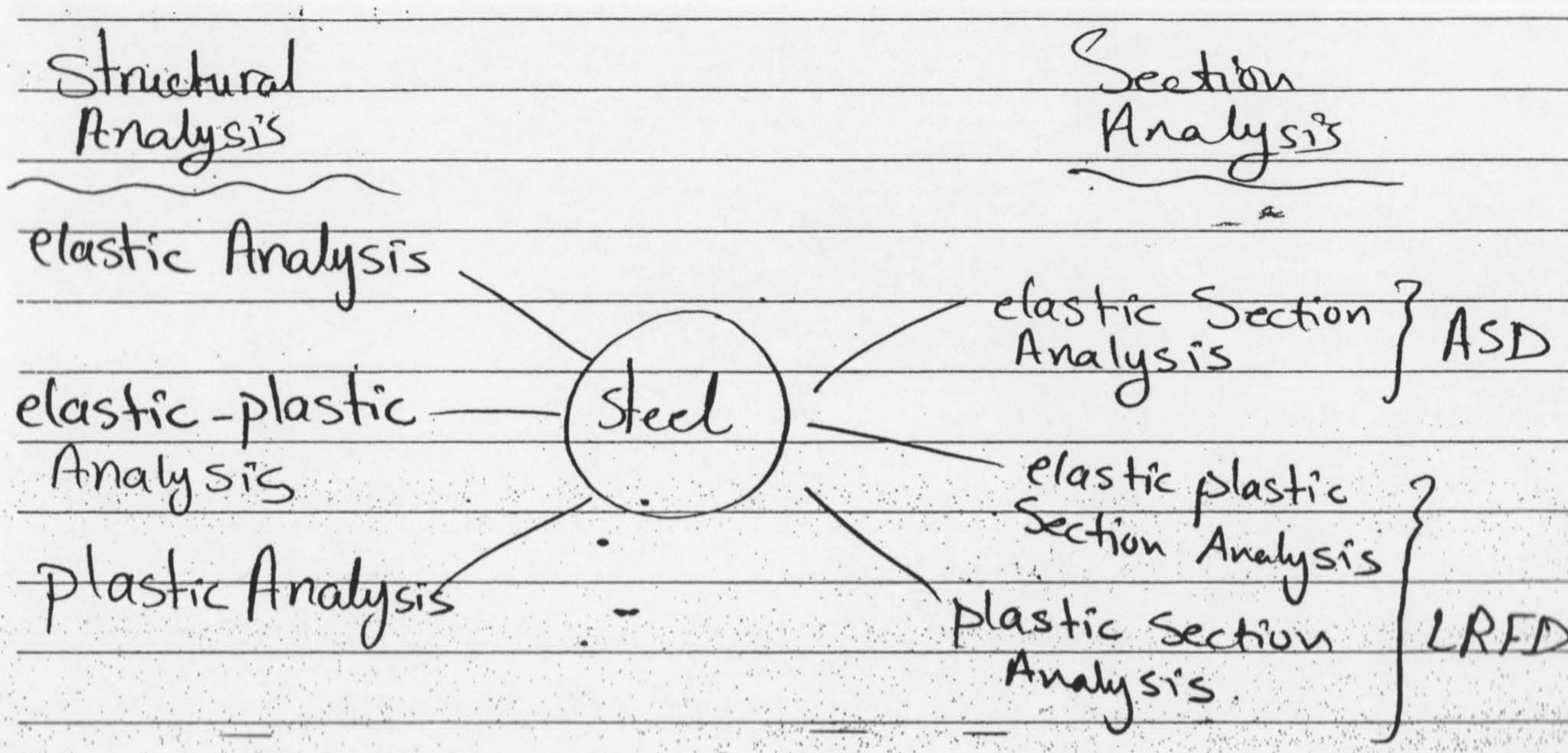
Internal work = external work

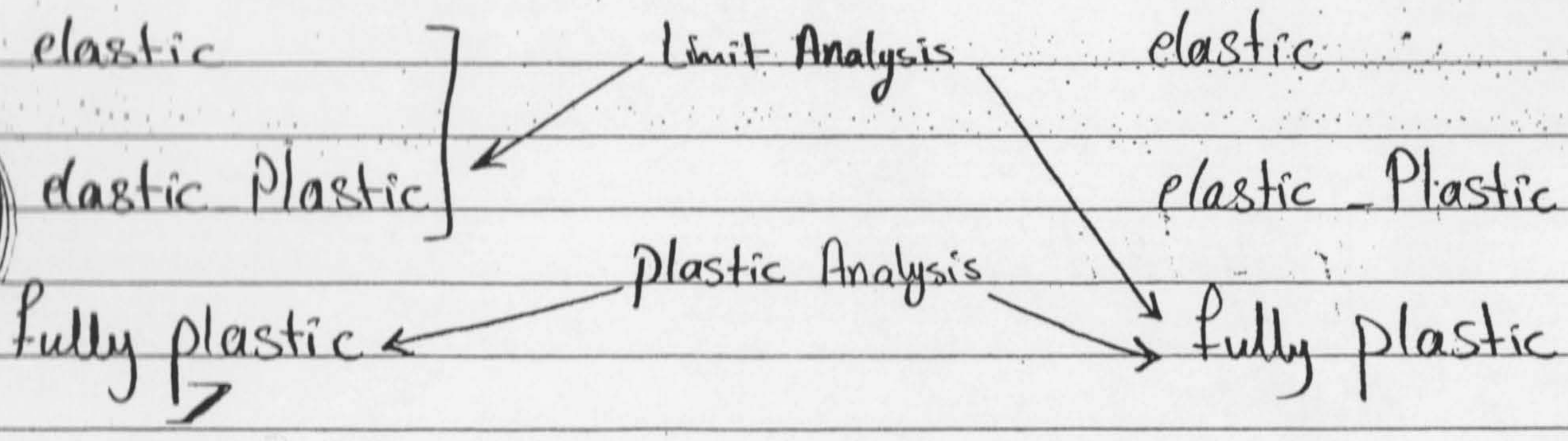
$$M_p \cdot \theta = P \cdot \delta$$

$$M_p \cdot \frac{\delta}{L} = P\,\delta$$

$$\boxed{M_p = PL}$$

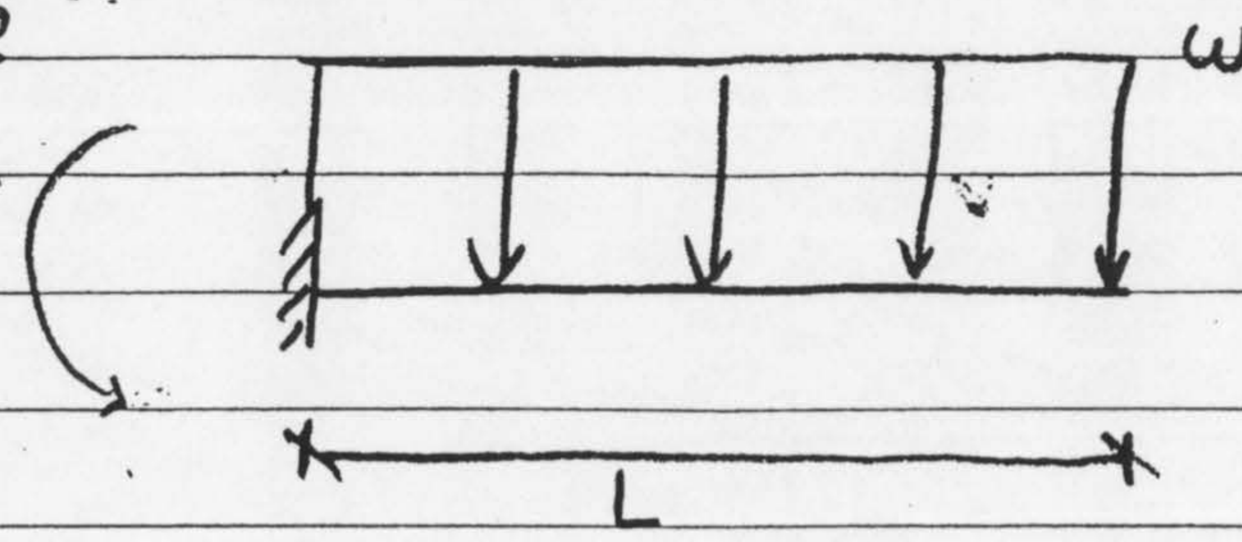
notes. الـ elastic تحليله الـ Beam اعتيادياً.
الـ plastic يعتمد على مبدأ الحمل الأقصى
مساوي للشغل الخارجي.



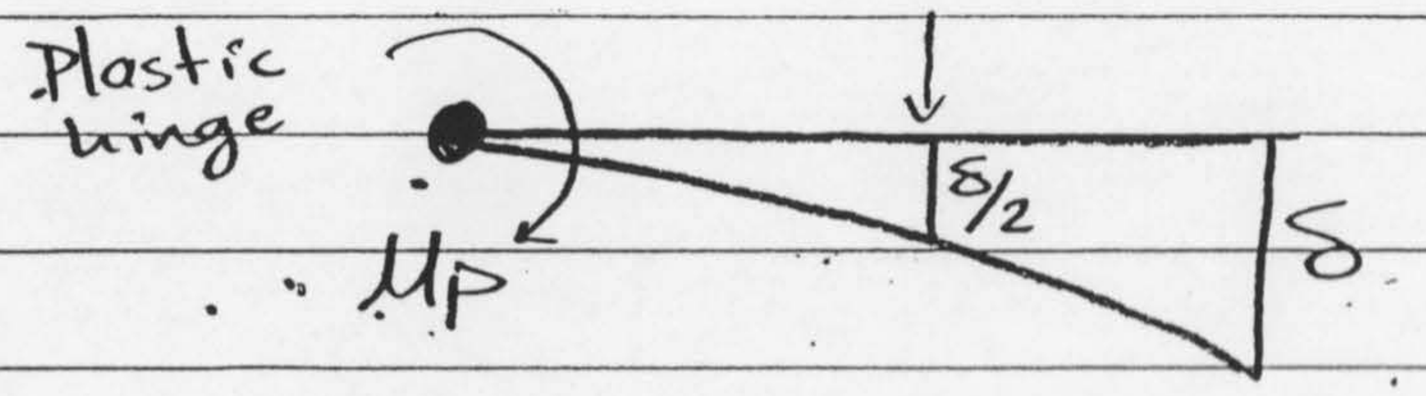


Winner Line

Ex:



elastic



Plastic

Internal work = External work

$$M_p \cdot \theta = \underbrace{wL}_{Force} \left(\frac{\delta}{2}\right)$$

→ مقدار النزول تحت اللود

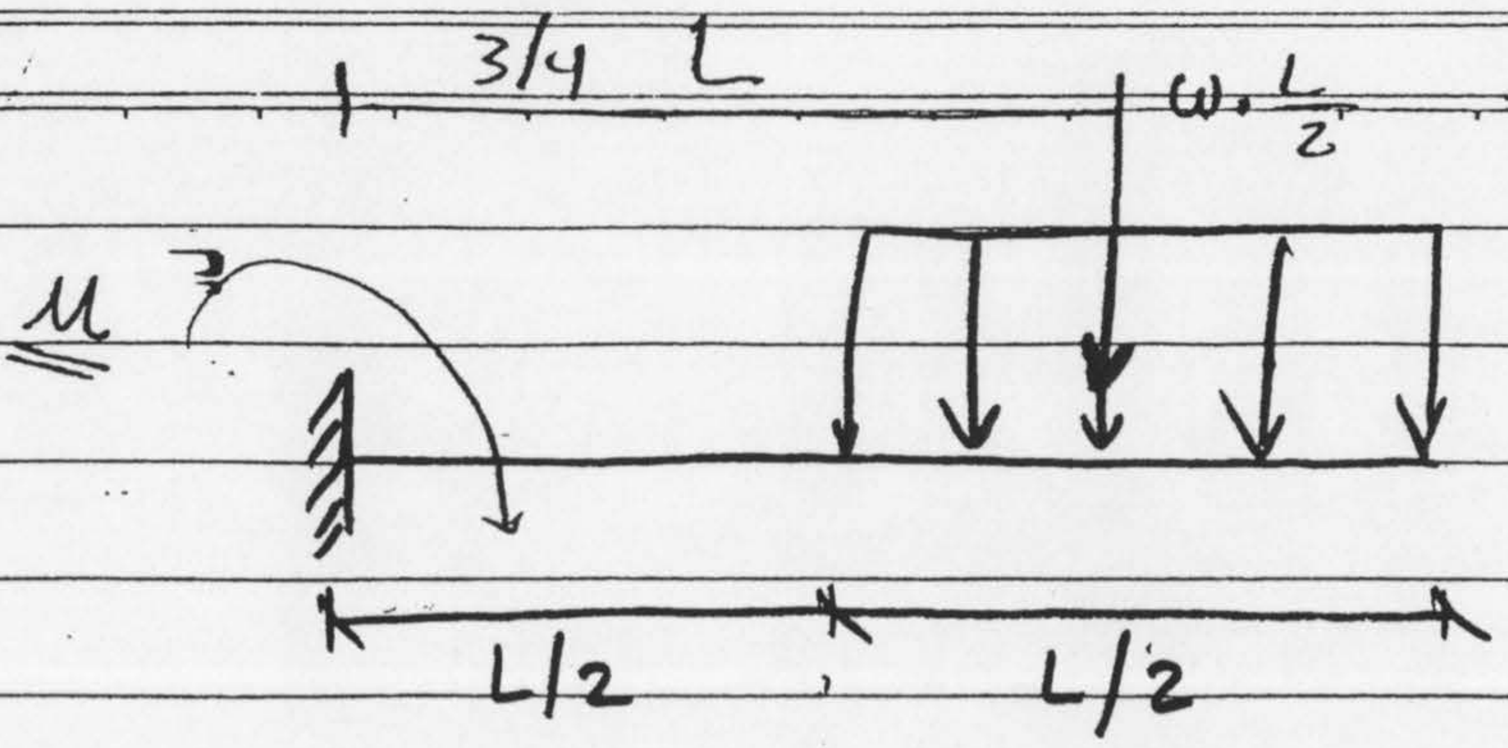
→ حول ال uniform ال concentrated

$$M_p \cdot \frac{\delta}{L} = wL \cdot \frac{\delta}{2}$$

$$M_p = \frac{wL^2}{2}$$

* رح تكون نفسه ال Me اذا
مثلا ال Cantlive

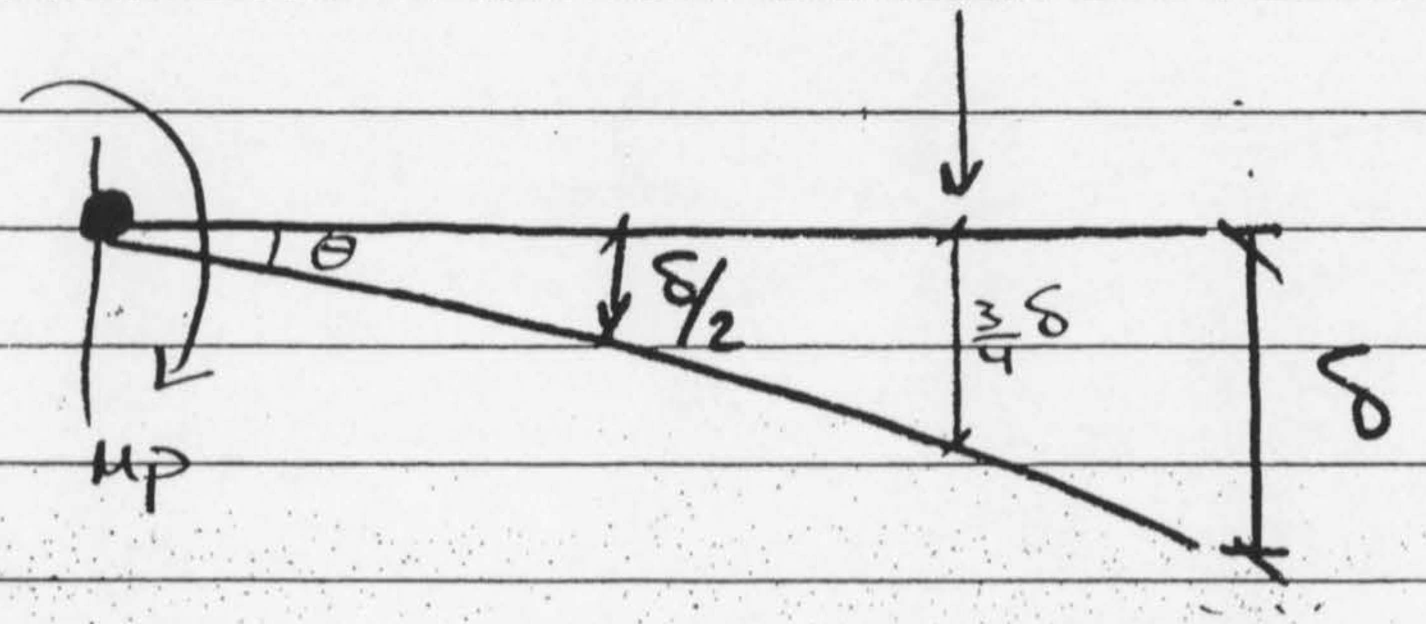
Ex:



$$M = \frac{\omega L}{2} \times \frac{3}{4} L$$

$$= \frac{3}{8} \omega L^2$$

Plastic hinge



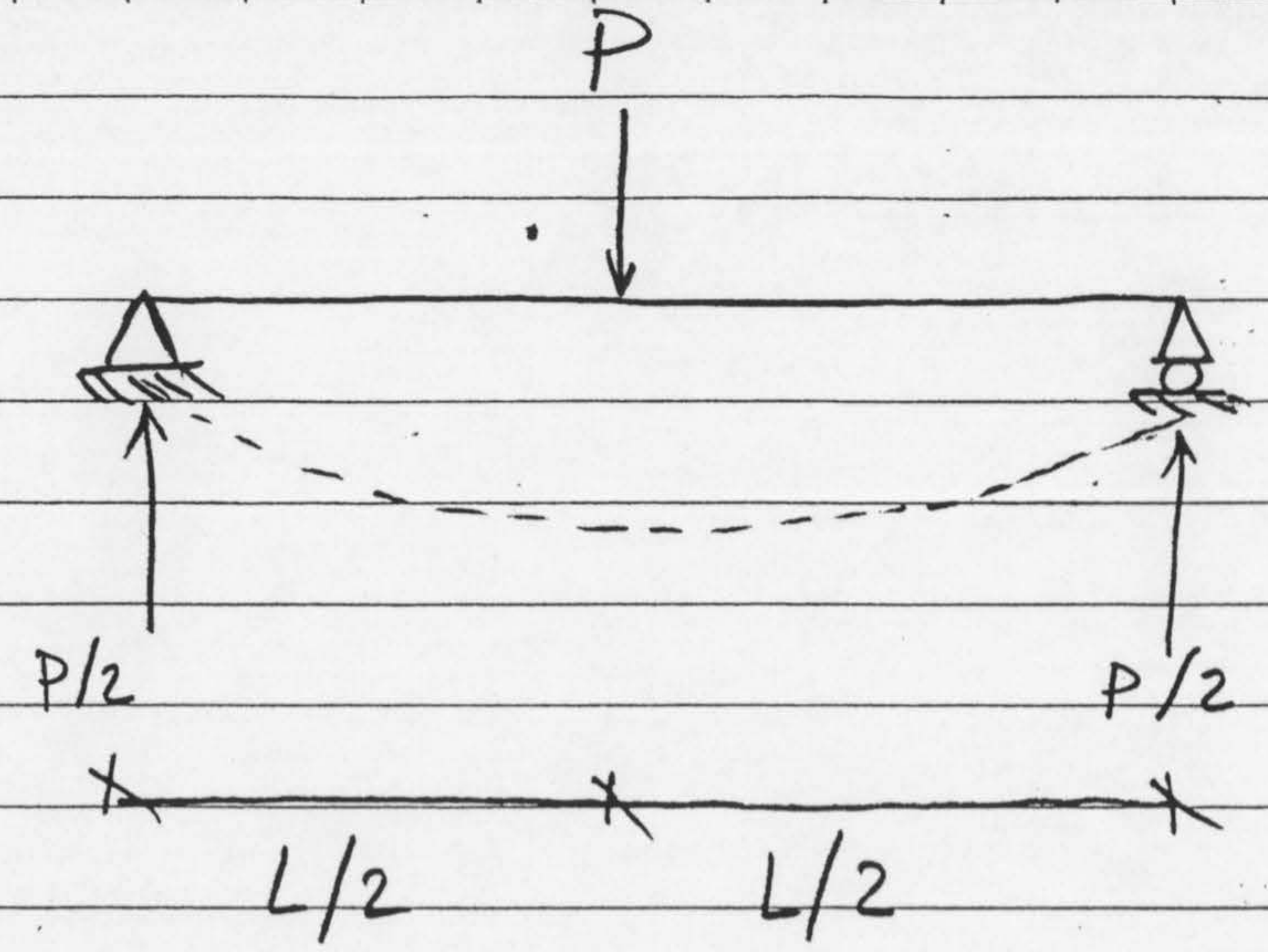
Internal work = External work

$$M_p . \theta = \frac{\omega L}{2} . \frac{3}{4} \delta$$

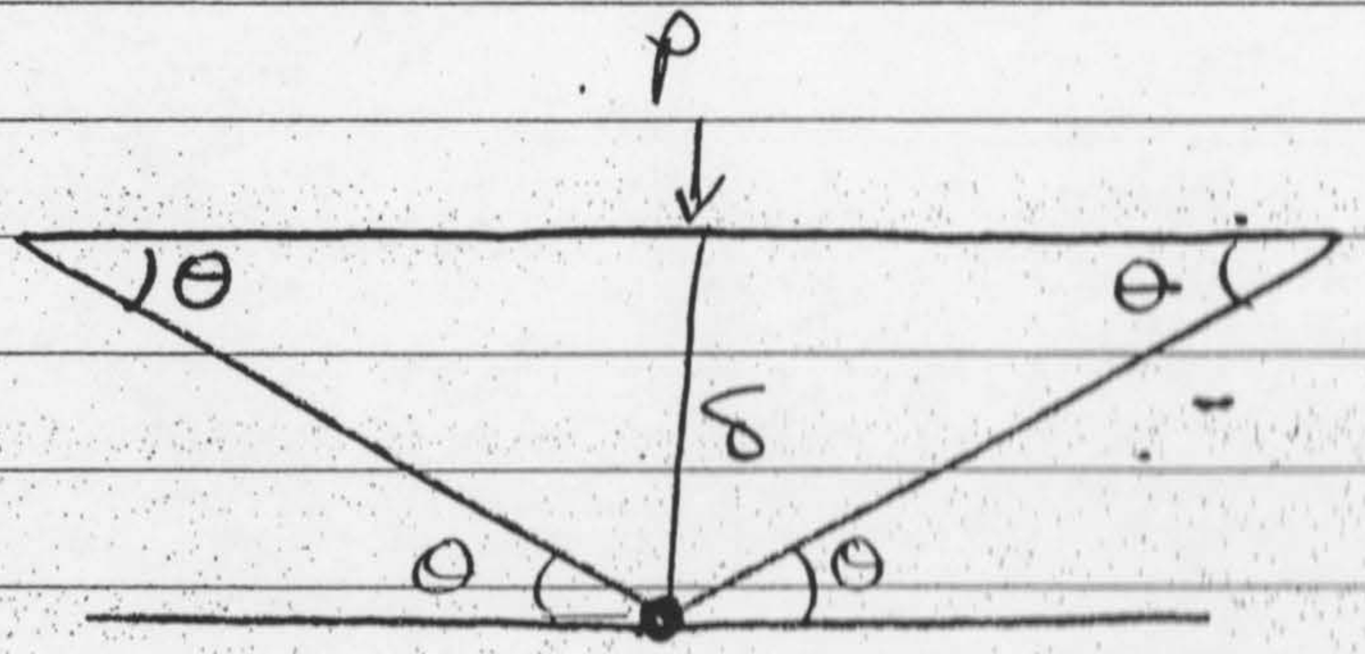
$$M_p . \frac{\delta}{L} = \frac{\omega l}{2} . \frac{3}{4} \delta$$

$$M_p = \frac{3}{8} \omega L^2$$

Ex:



$M = \frac{PL}{4}$



Internal work = External

$M_p \cdot 2\theta = P\delta \qquad , \theta = \frac{\delta}{L/2}$

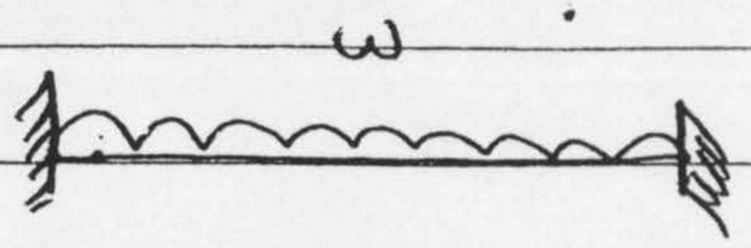
$M_p \cdot 2\frac{\delta}{L/2} = P\delta$

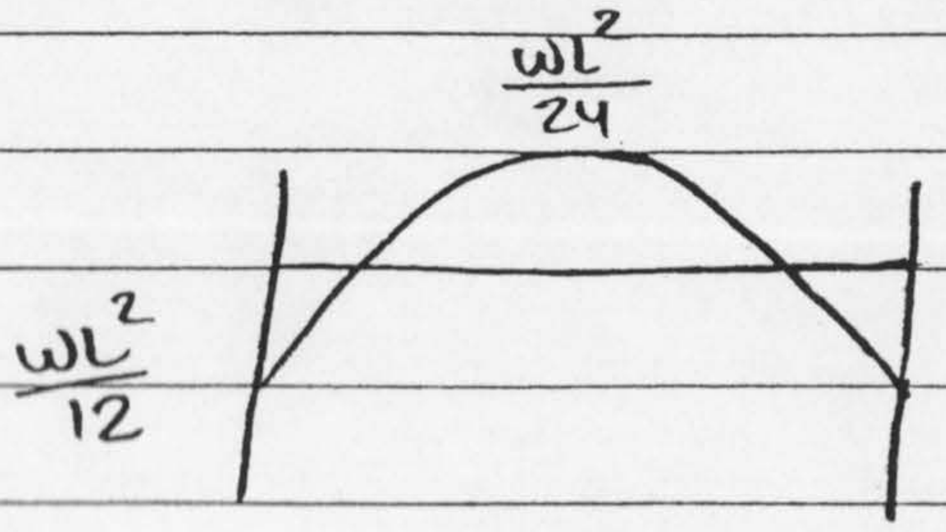
$4M_p = PL$

$M_p = \frac{PL}{4}$

★ Limit Analysis (lower bound Solution)

Ex)



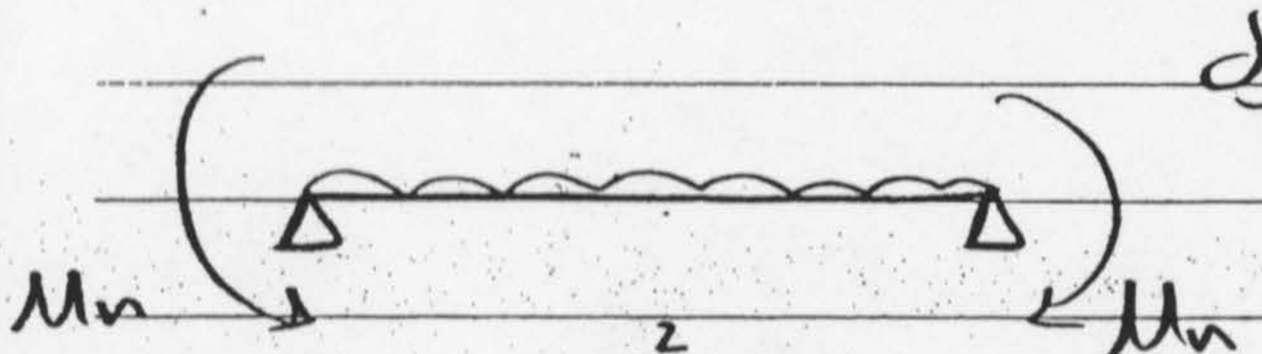


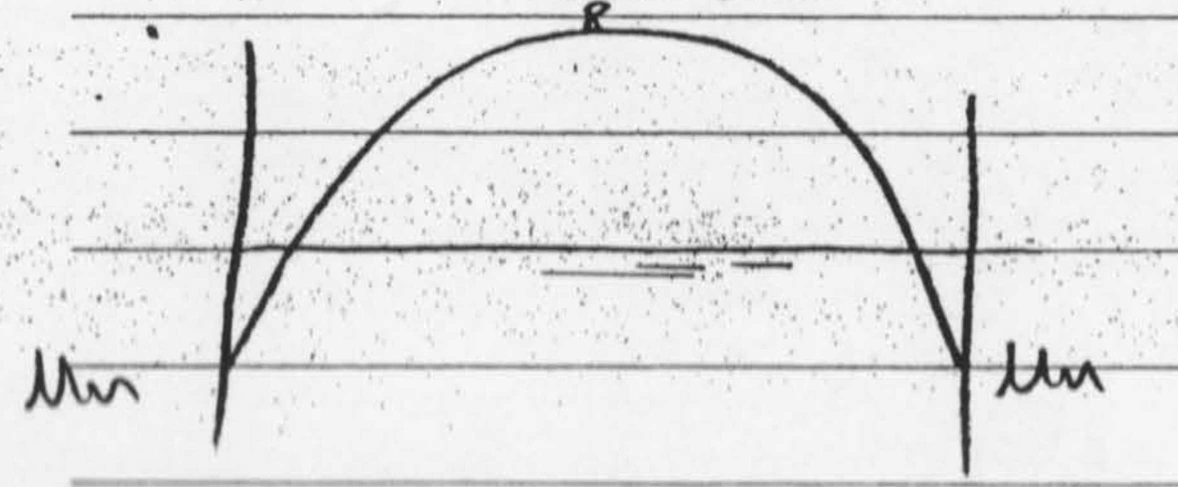
$$\frac{wL^2}{12} = M_n \rightarrow \text{تحمل القطاع}$$

$$w_{elastic} = \frac{12 M_n}{L^2}$$

* لا يوجد فشل

وعند زيادة اللود يحدث الفشل فيتحول ال fixed الى hinged أي يتحول من indeterminate الى determinate



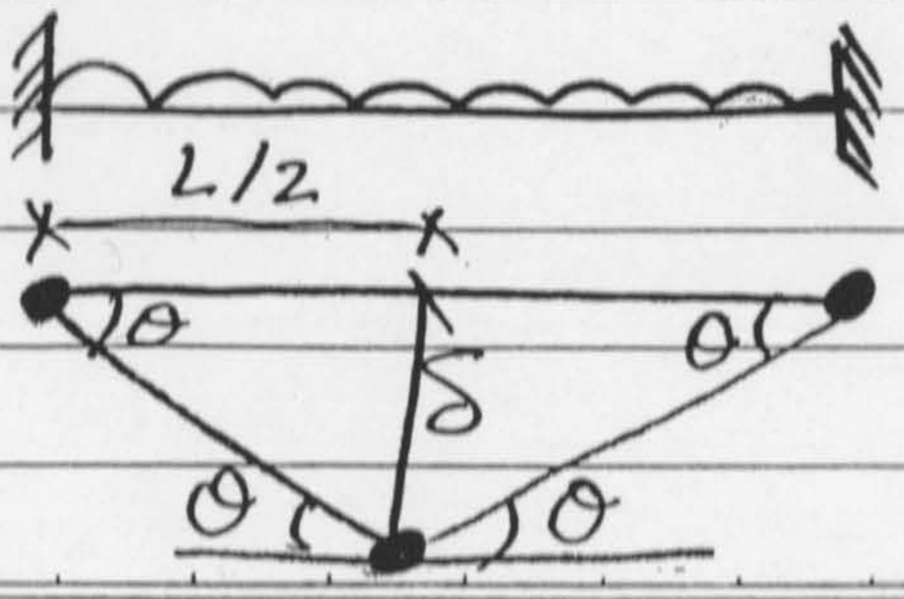


$$\frac{wL^2}{8} - M_n = M_n$$

$$\omega_{collapse} = \frac{16 M_n}{L^2}$$

★ Plastic Analysis (upper bound Solution)

فقط يفشل البيم يحتاج الى 3 plastic hing فيتحول ال fixed
ال plastic hinge ونضع واحد بالمنتصف

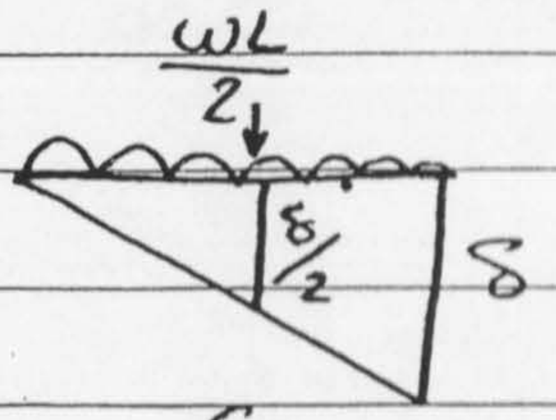


$$\theta = \frac{\delta}{L/2}$$

$$\therefore \theta = \frac{2\delta}{L}$$

$P \cdot \delta$

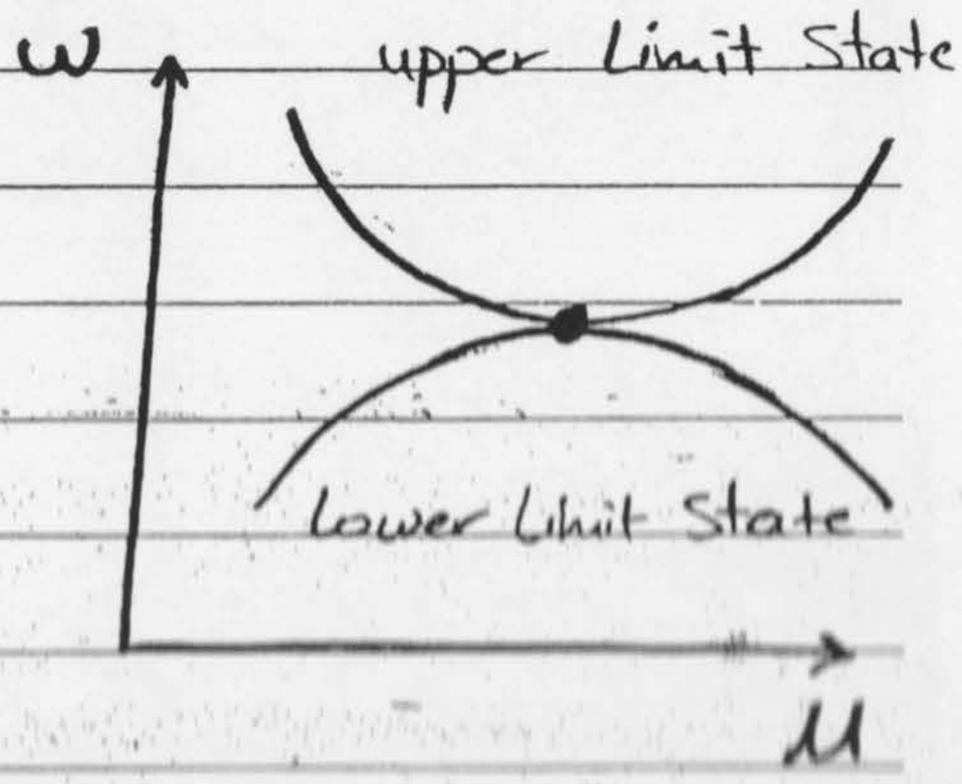
$$E.W = 2 * \frac{wL}{2} * \frac{\delta}{2} = \frac{wL\delta}{2}$$



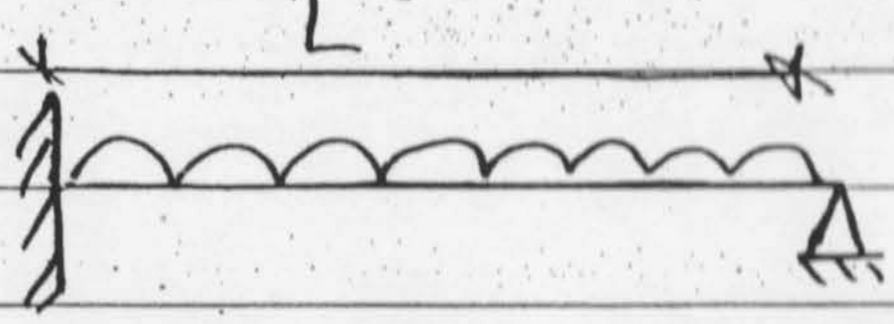
$$I.W = (M_p\theta + M_p\theta) * 2$$
$$= 4 M_p \theta$$

* ناقد نفس الشكل وتضرب الناتج بـ (2)

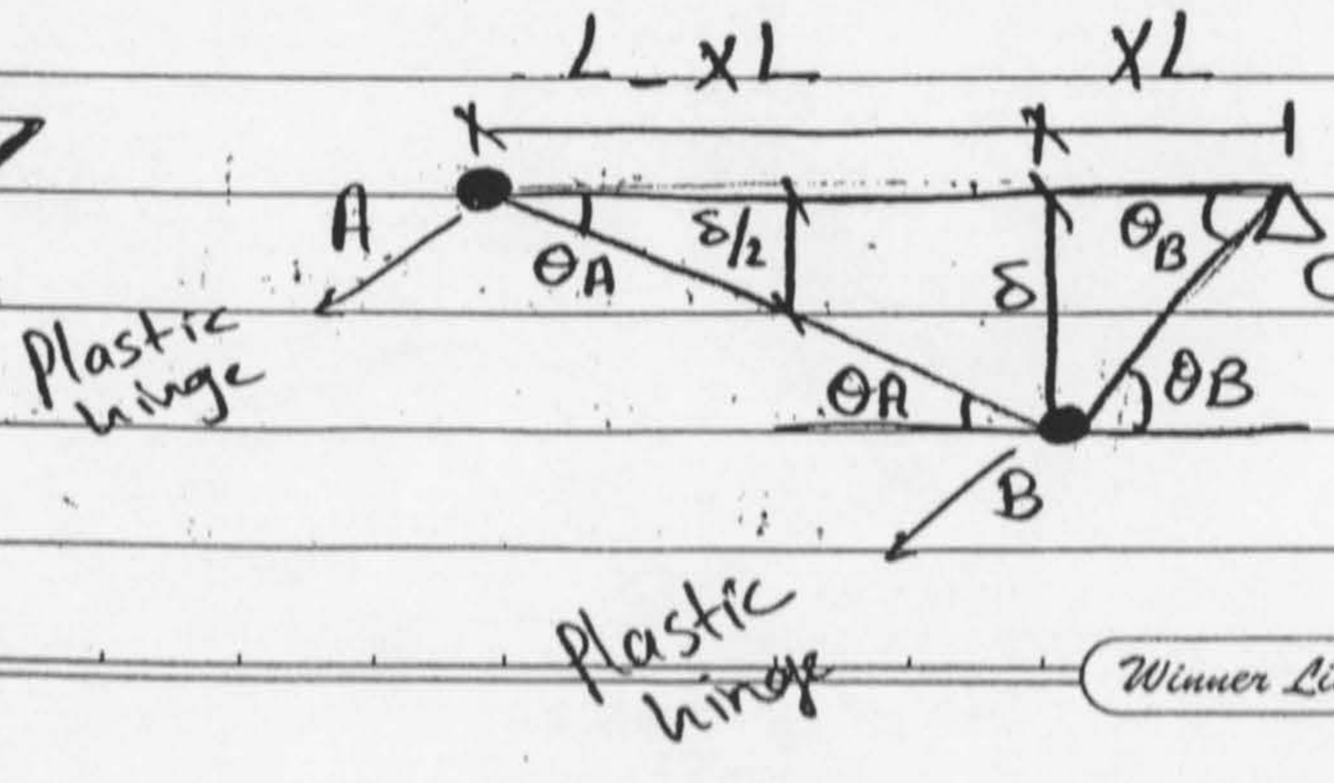
$$I.W = E.W$$
$$4M_p\theta = \frac{wL\delta}{2}$$
$$4M_p * \frac{2\delta}{l} = wl\frac{\delta}{2}$$
$$\therefore \quad w = \frac{16 M_p}{L^2}$$



Ex)



note : لازم نحط 2plastic hing الاول بمكان الـ fixed
والثاني يكون مكانه غير معروف (المفروض يكون قريب
ع الضعيف اللي هو hinged) فنا قد على بعد X من الـ hingel



$$\theta A = \frac{\delta}{L - XL}$$
$$\theta B = \frac{\delta}{XL}$$

$$E.W = E.W(AC) + E.W(CB)$$

$$= w.(L - xL)\frac{\delta}{2} + w.xL.\frac{\delta}{2}$$

$$= wL.\frac{\delta}{2} - w.xL.\frac{\delta}{2} + w.xL.\frac{\delta}{2}$$

$$E.W = w.L.\frac{\delta}{2}$$

$$I.W = M_p.\theta_A + M_p\theta_A + M_p.\theta_B$$

$$= 2M_p\theta_A + M_p\theta_B$$

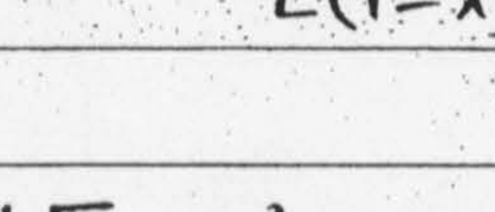
$$= 2M_p\frac{\delta}{L(1-x)} + M_p\frac{\delta}{xL}$$

$$I.W = E.W$$

$$2M_p\frac{\delta}{L(1-x)} + M_p\frac{\delta}{xL} = w.L.\frac{\delta}{2}$$

$$w = \frac{4M_p}{L^2(1-x)} + \frac{2M_p}{xL^2}$$

$$w = \frac{2M_p}{L^2}\left[\frac{2}{(1-x)} + \frac{1}{x}\right] \quad \text{------ eq (1)}$$



اقل قيمة تكون في حالة
الـ lower unit state حيث
تكون الشكل تقعر فلازم
تشتق و تساوي للصفر.

ناتج من مشتقة
حاصل قسمة دالتين

$$\frac{2}{(1-x)^2} + \frac{(-1)}{x^2} = 0$$

$$\frac{2}{(1-x)^2} - \frac{1}{x^2} = 0$$

$$\frac{2}{(1-x)^2} = \frac{1}{x^2}$$

$$x^2 - 2x - 1 = 0 \rightarrow x_1 = 0.414, \quad x_2 = -2.414 \text{ (يهمل)}$$

$\therefore x = 0.414$ sub in eq ①

$$w = \frac{2M_p}{L^2}\left(\frac{2}{1-0.414} + \frac{1}{0.414}\right) \Rightarrow w = \frac{11.657 M_p}{L^2}$$

* assume Plastic hinge @ $x = 0.5$ ناخذة بالمنتصف

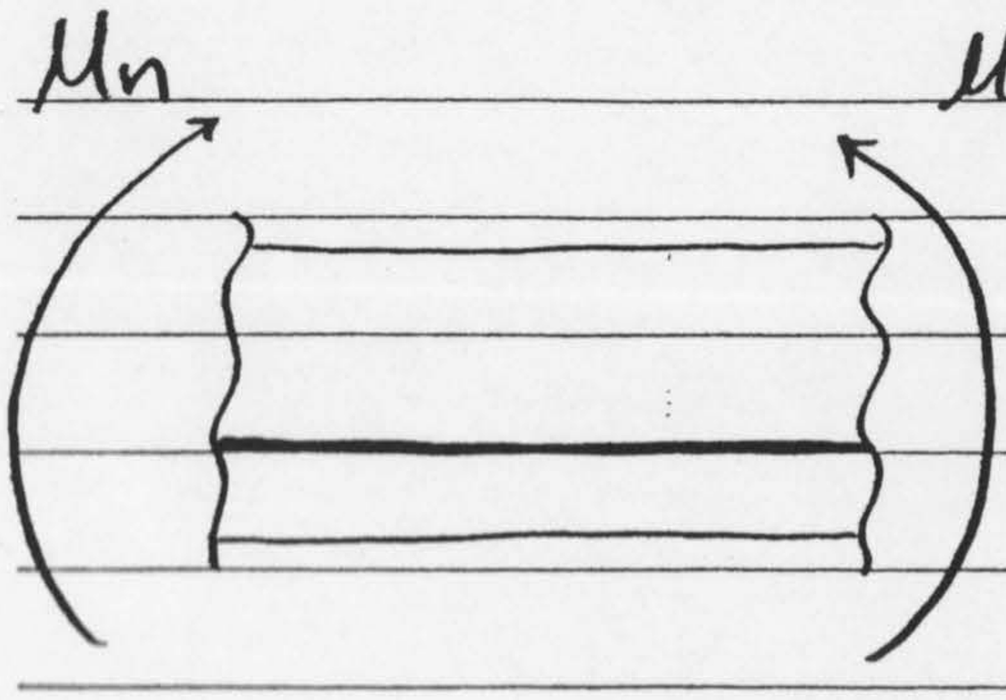
$$w \cdot L \cdot \frac{\delta}{2} = 3M_p \, \theta$$

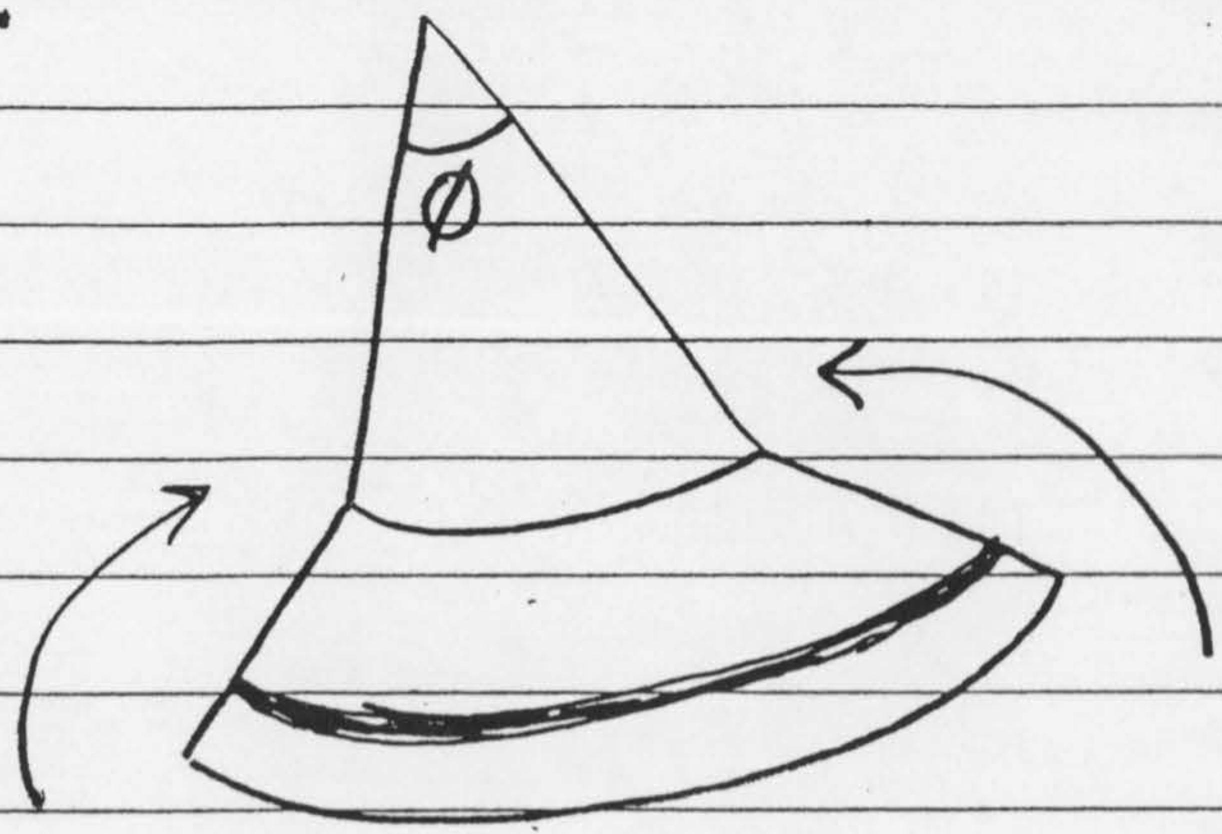
$$w \cdot L \cdot \frac{\delta}{2} = \frac{2}{L}\delta * 3M_p$$

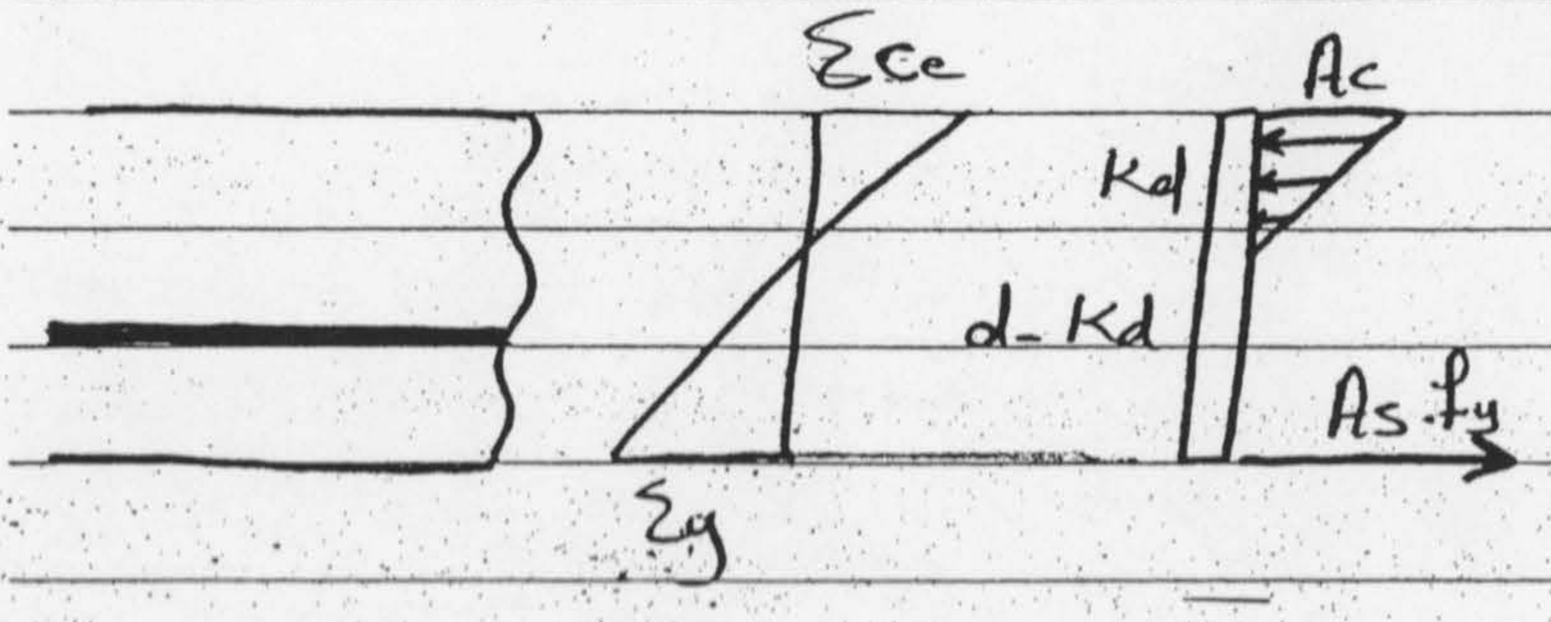
$$w = \frac{12 M_p}{L^2}$$

note : المقترح ناخذ اقل حمل يسبب Collapse
يعني بعد ال plastic hinge عن ال hinge هو 0.414
والحمل $\left(w = \frac{11.627 M_p}{L^2}\right)$

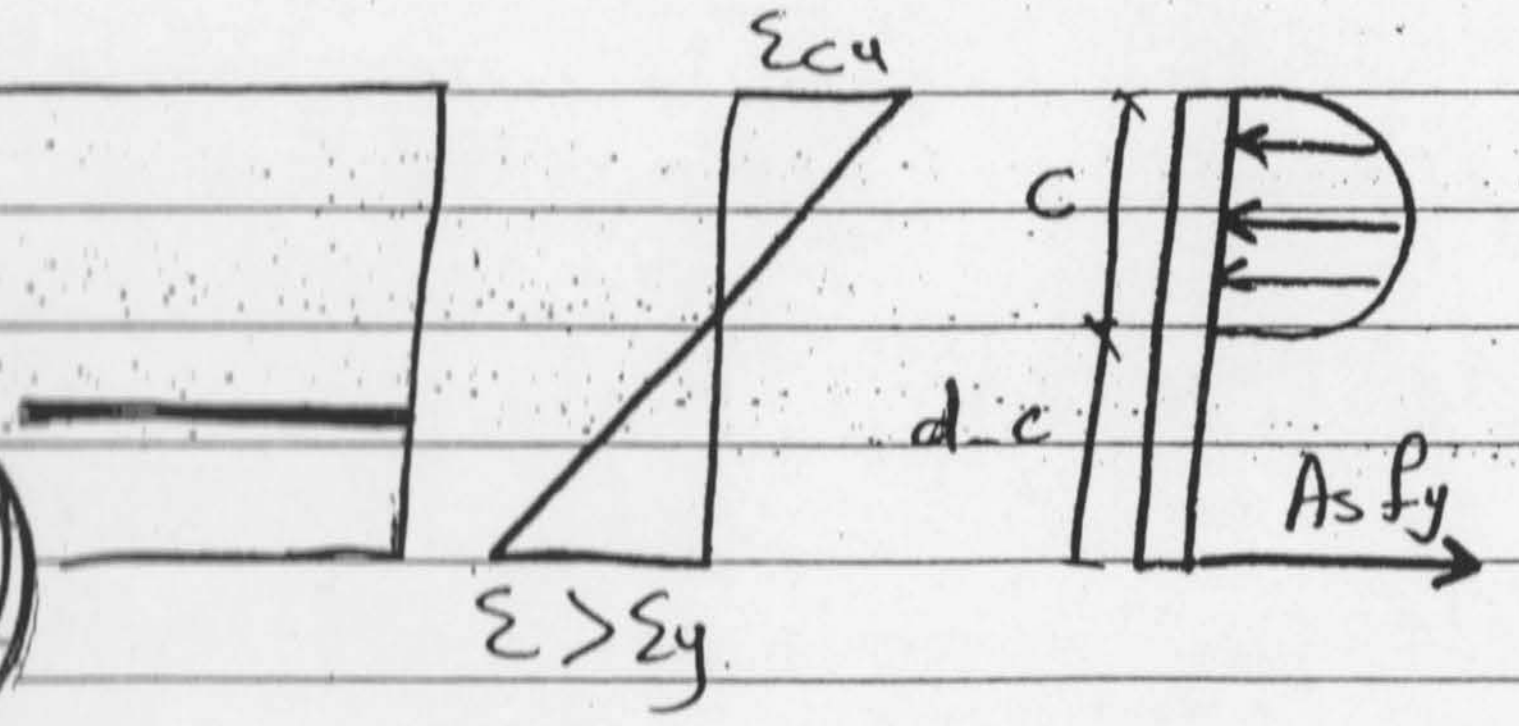
"ductility of Concrete"

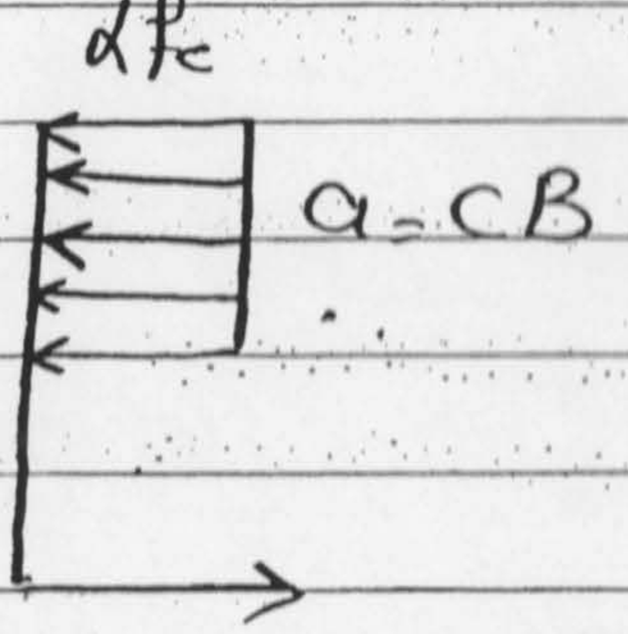






$$M_y = A_s f_y \left(d - \frac{Kd}{3}\right)$$



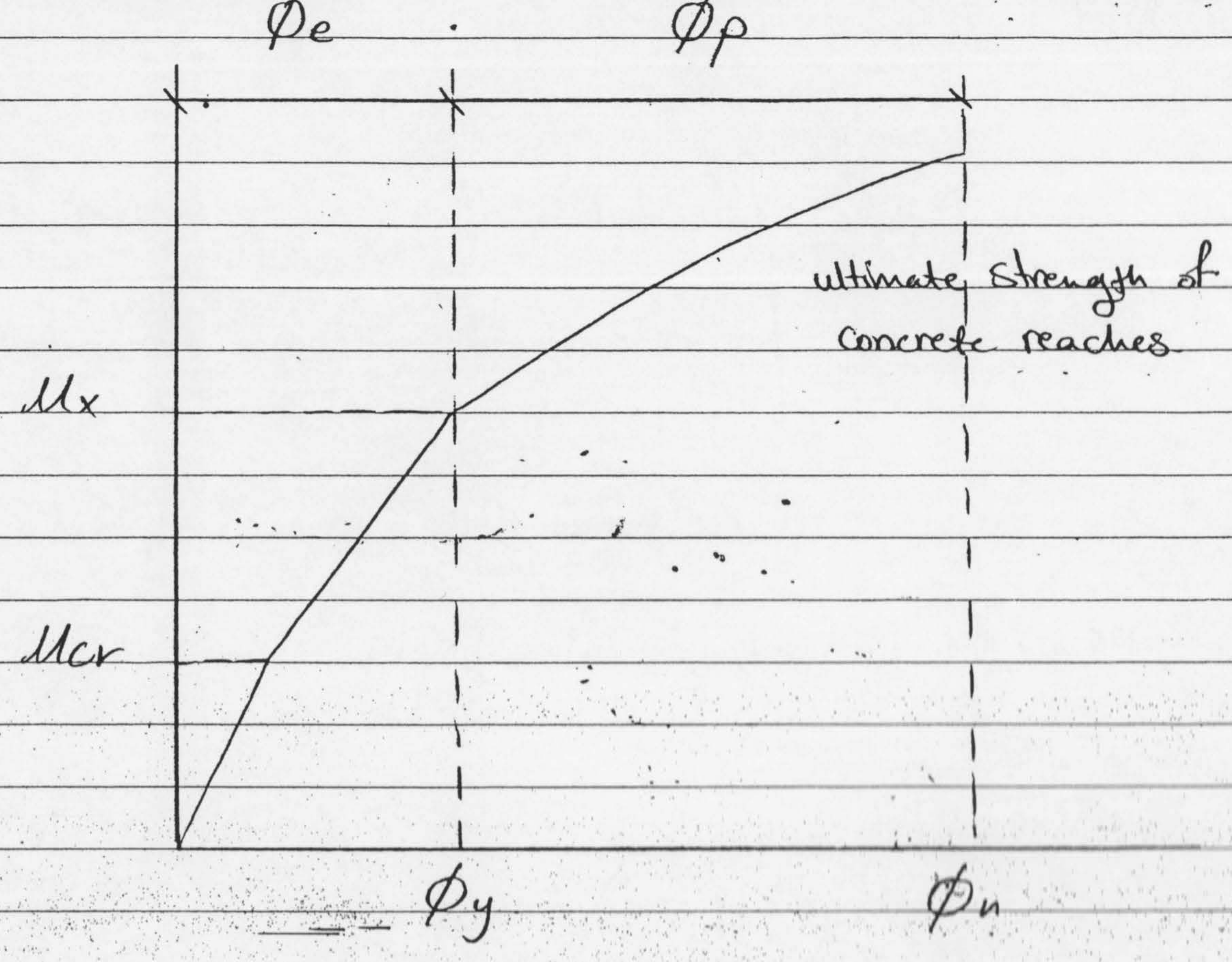


$f_c = 20.7$

$f_y = 276$

$\frac{\phi_u}{\phi_y}$	4	6	10	23
ρ	0.02	0.015	0.01	0.005

Winner Line



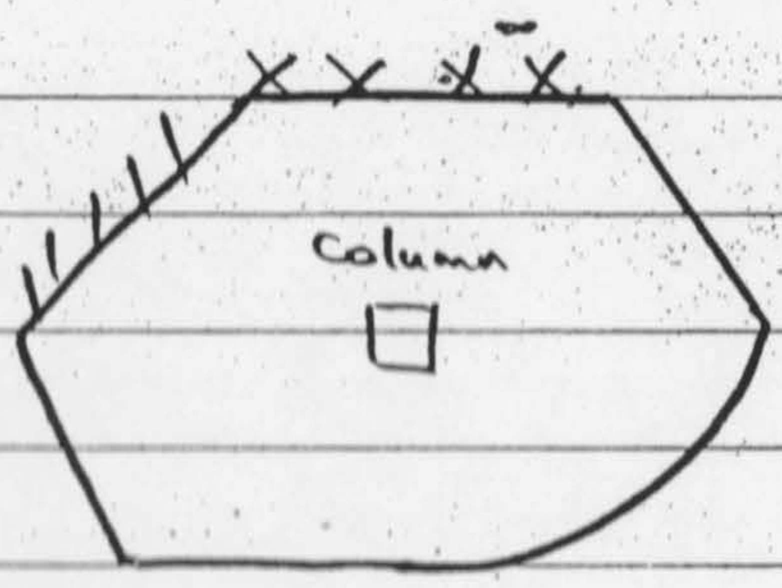
Winner Line

Yield Line theory

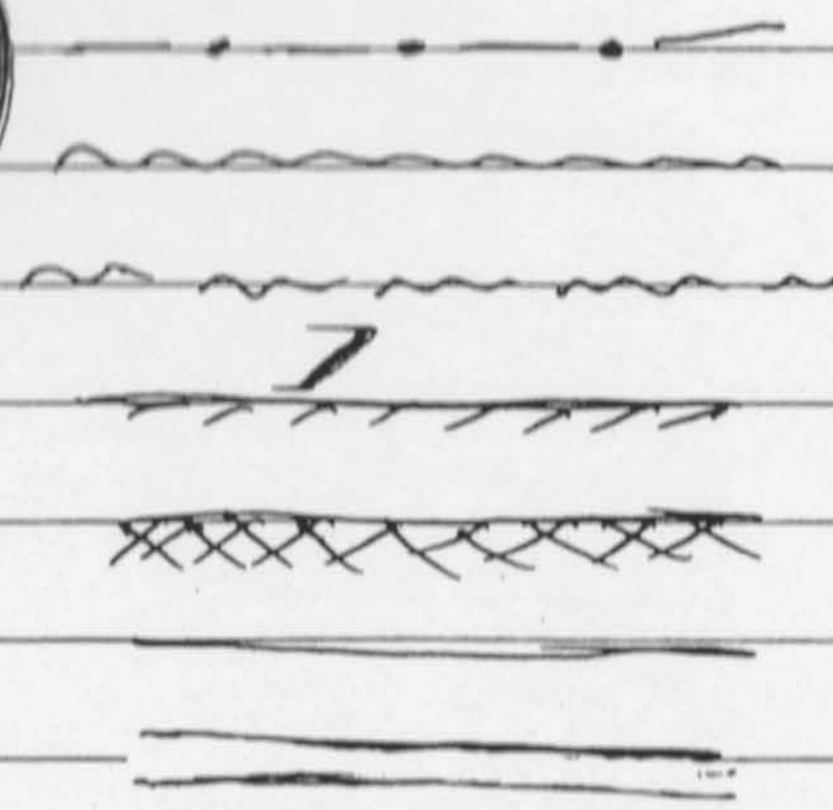
non-uniform (Shape, loading) of slab:
- Yield Line theory (upper bound Solution)
- Strip method (lower bound Solution)

* اللود اللي نحصله من هذه الطريقة أما يساوي أو أكبر من لود الفشل.

* بهذه الطريقة عند التحليل ناخذ كل Pannel على حدى ونجد لها لود ونجيب ناخذ أقل لود.



Notations



Axis of rotation.
Positive Yield Line
Negative Yield
Simply Supported
fixed or continous Supports
free edge.
Beam

▧ ⊘ ◬ Column.

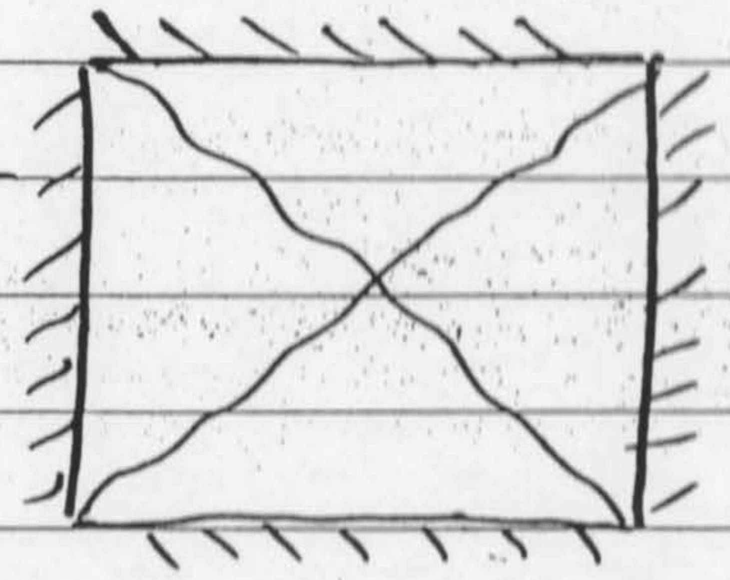
○ Point load (Concrete rate load)

note الـ Positive Yield Line مستقيم بين محور دوران.

note عدد الـ Segment بعدد محاور الدوران.

note تكون الـ Yield line positive من تقاطع محاور الدوران

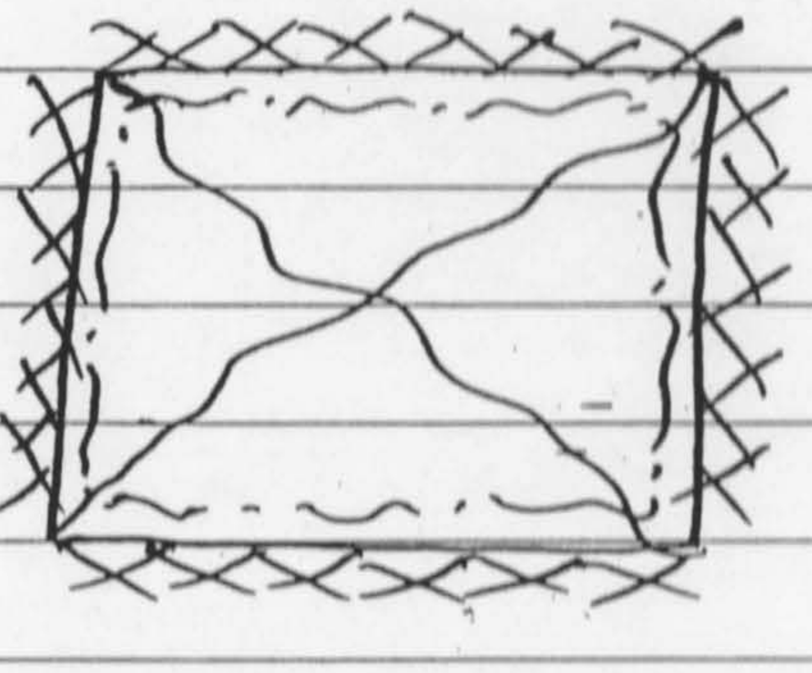
Simply Supported



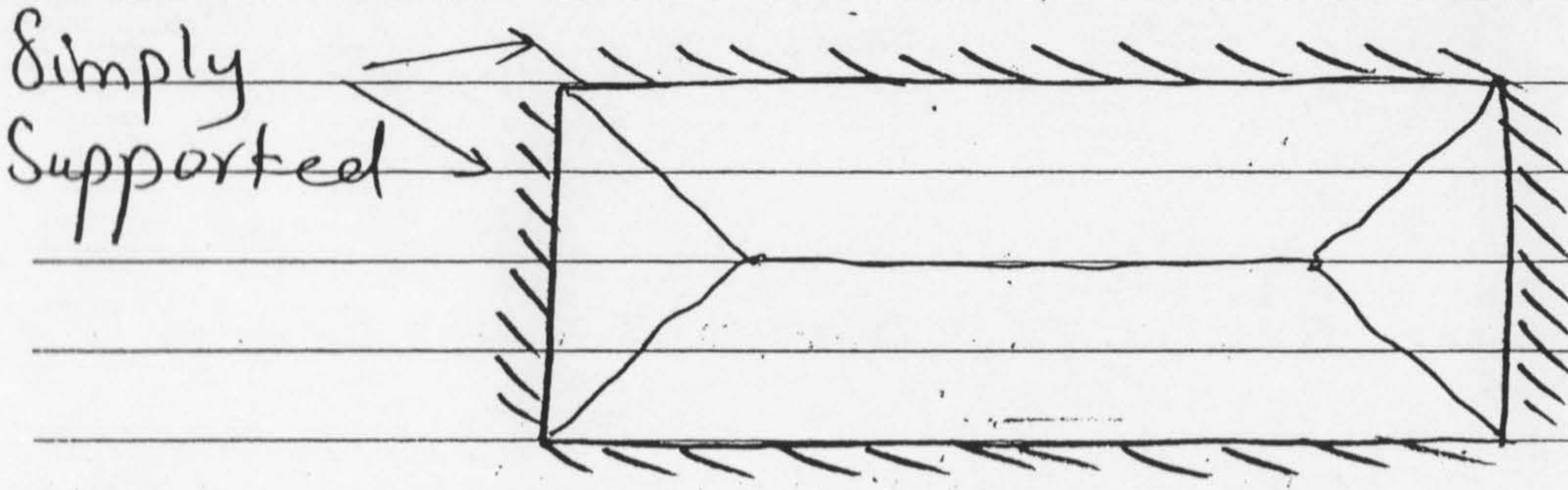
عندي ٤ محاور دوران و ٤ (Segment)

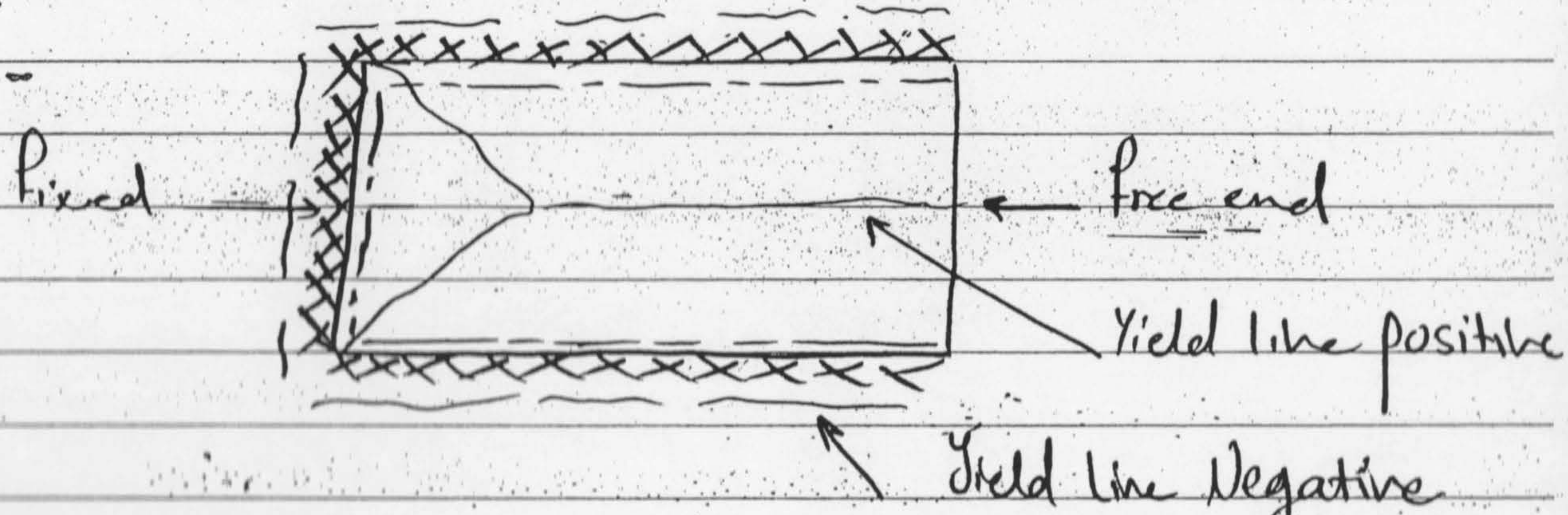
اما اذا كان عندي fixed تكون ٤ محاور موجبة و ٤ محاور سالبة

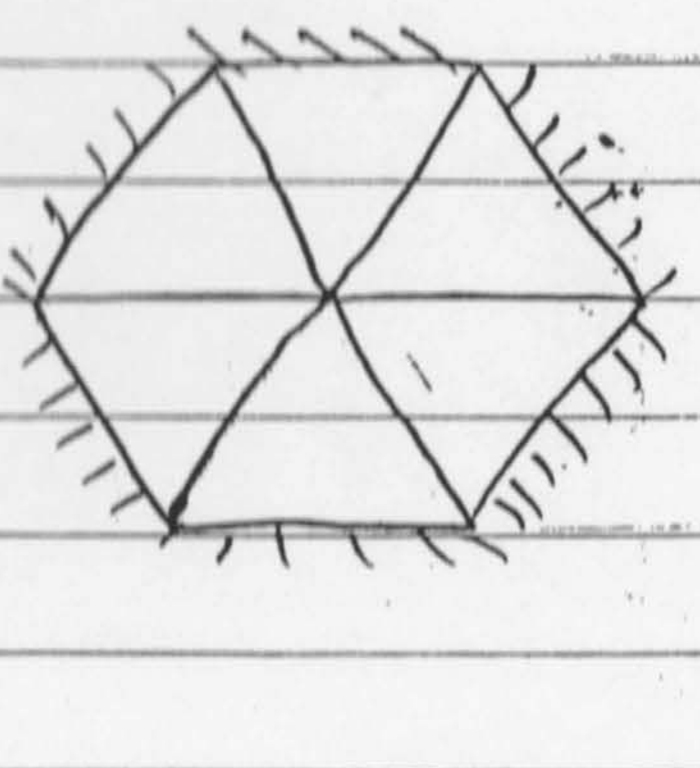
fixed →

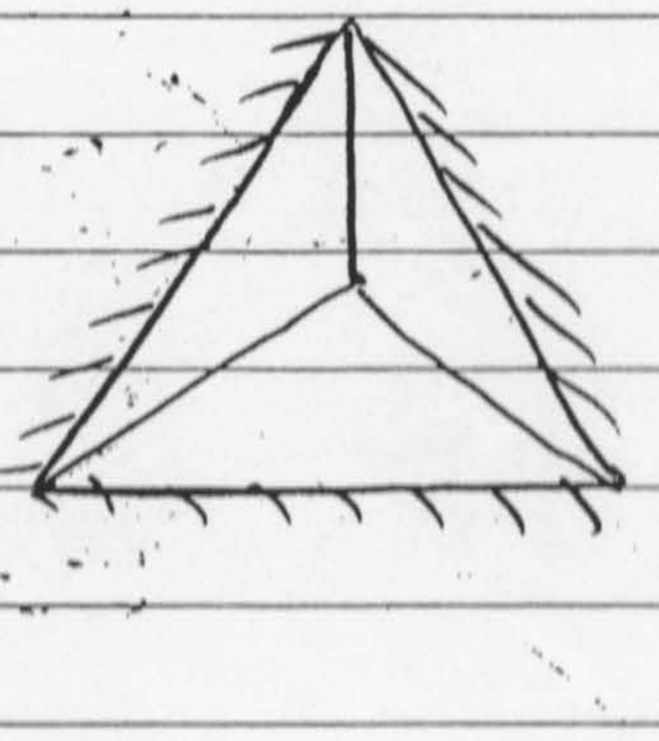


. Note الـ Yield Line Posites
تكون اما من التقاء محاور الدوران أو امتدادها.
او تلتقي الـ Yeild line positive مع بعضهم وتكون
Yield Line positive جديدة



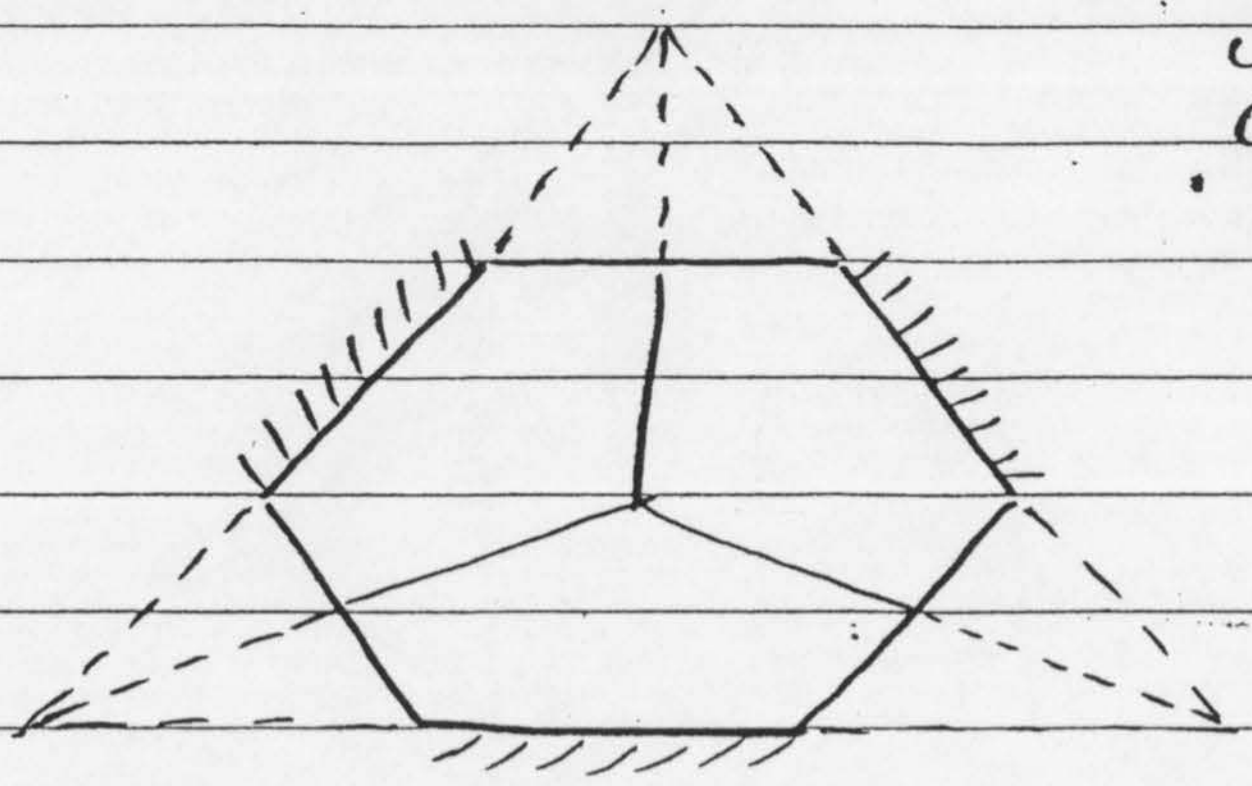




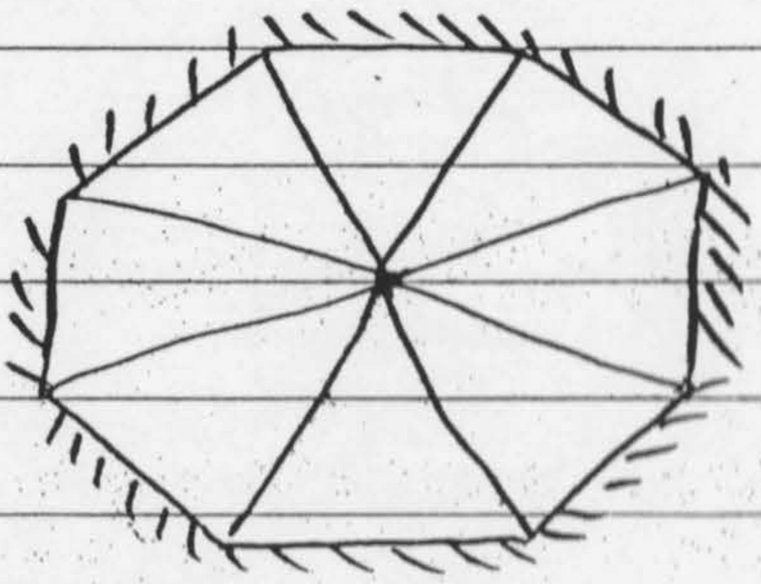


التاريخ / / ٢٠١ — الموضوع :

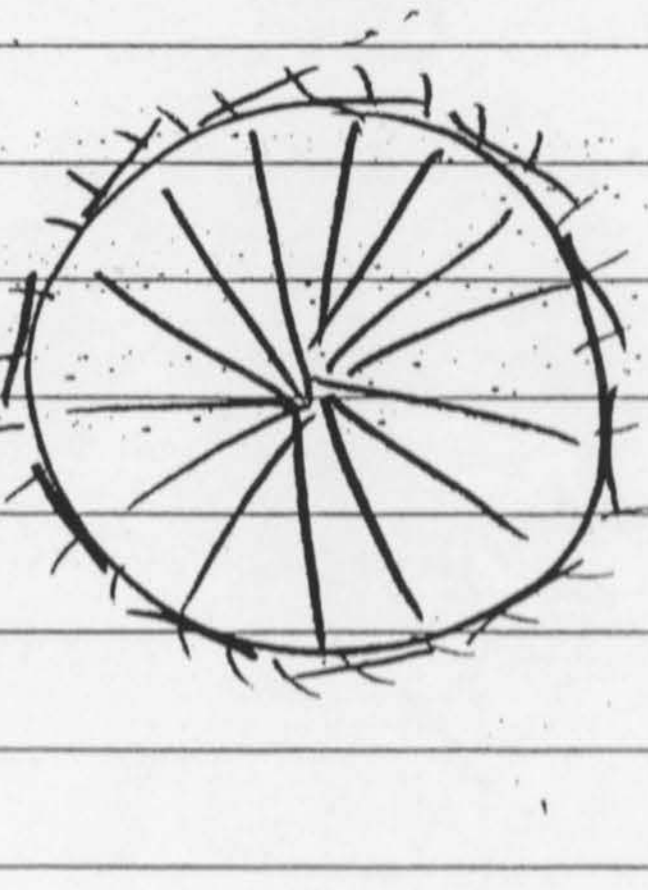
* الـ Yield Line Positive تكون من التقاء امتداد محاور الدوران.



الشكل ثماني فيكون عندي 8 Segment.

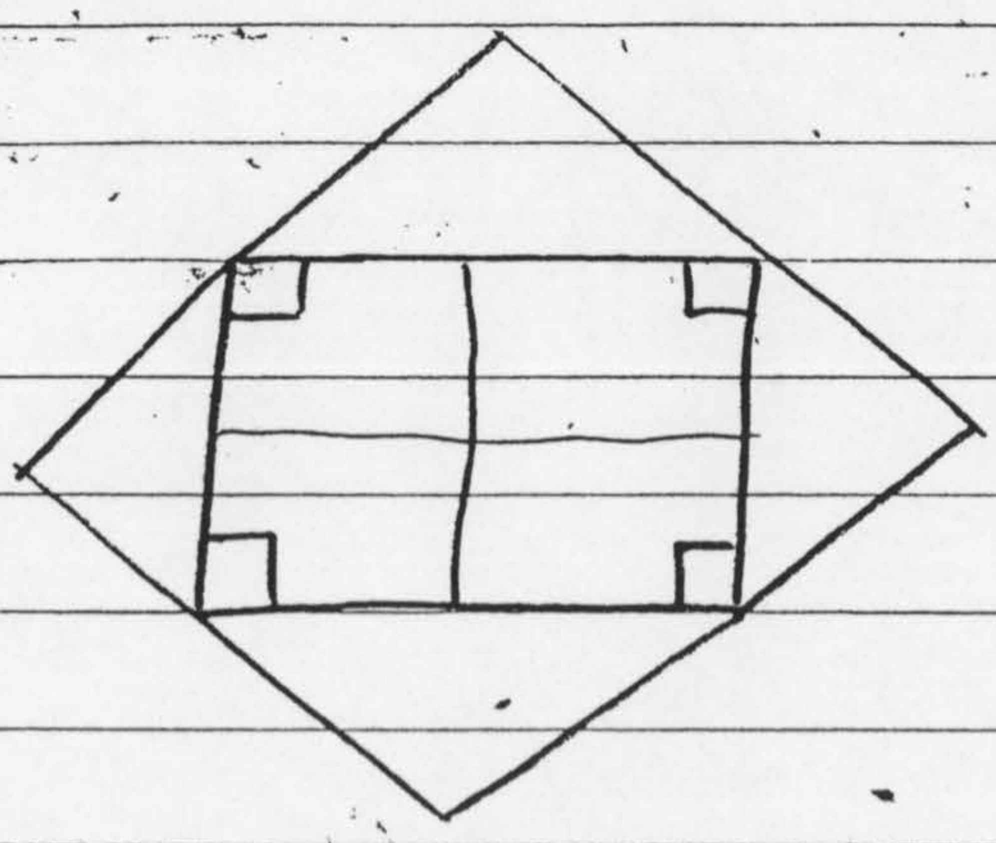


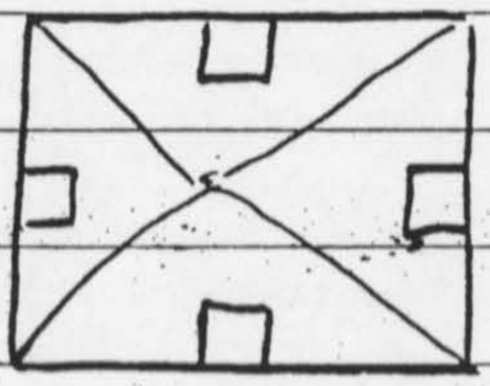
أما اذا كان الشكل دائرة فيكون الـ Yield Line هو عبارة عن التقاء الاعمدة على المماسات لكافة الدائرة



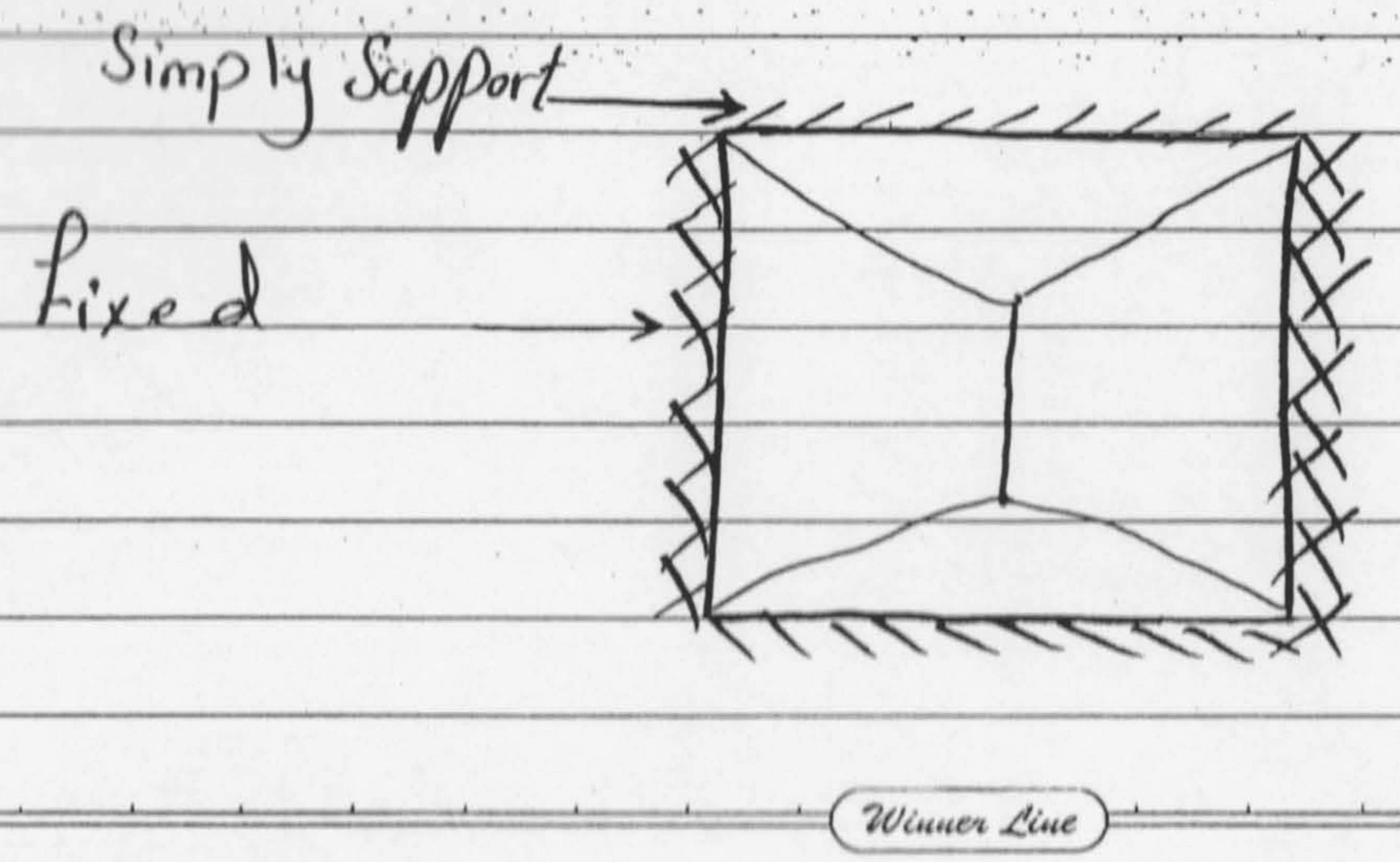
Winner Line

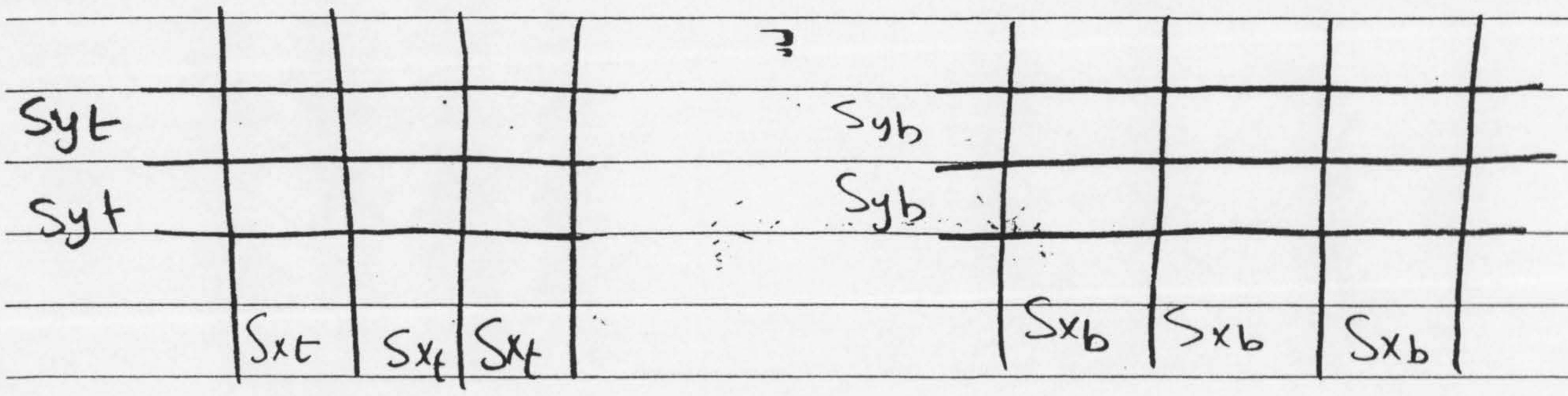
الـ Column تكون الـ Yield Line كالتالي :





في حالة عندي fixed و Simply فإن تقاطع
الـ Yield Line (تقاطع محاور الدوران)
تكون قريب من الـ (Simply Support)





$Syt = Syt$
$Sxb = Sxb$ } Isotropically Slab

$Syt \neq Syt$
$Sxb \neq Sxb$ } orthotropics Slab

$M = M_n = M_p$

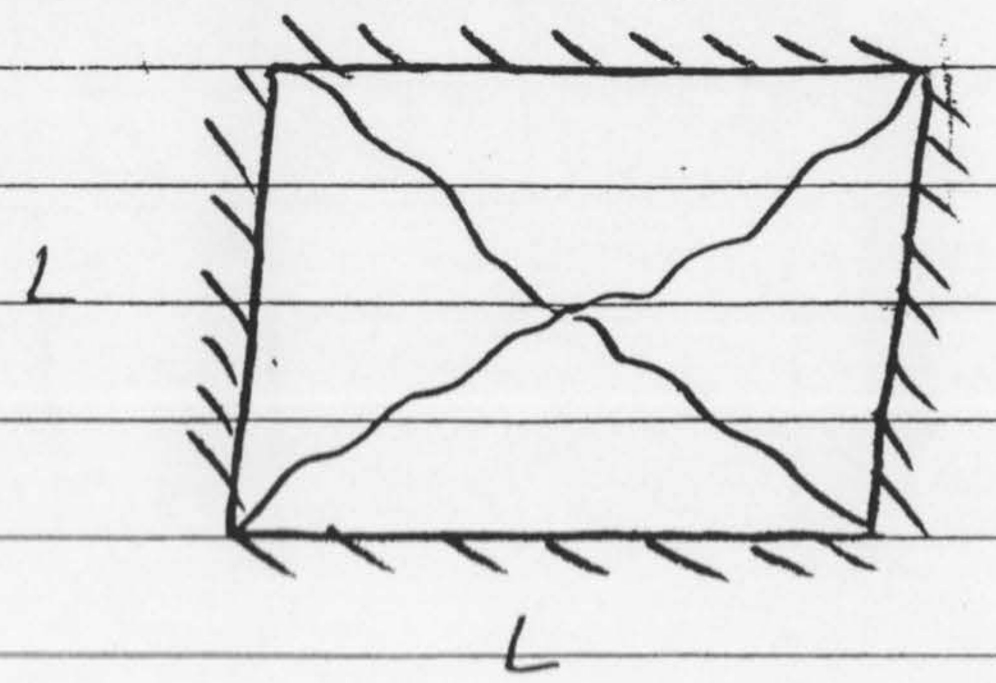
$$M = \rho f_y b d^2 \left[1 - 0.59 \rho \frac{f_y}{f_c} \right]$$

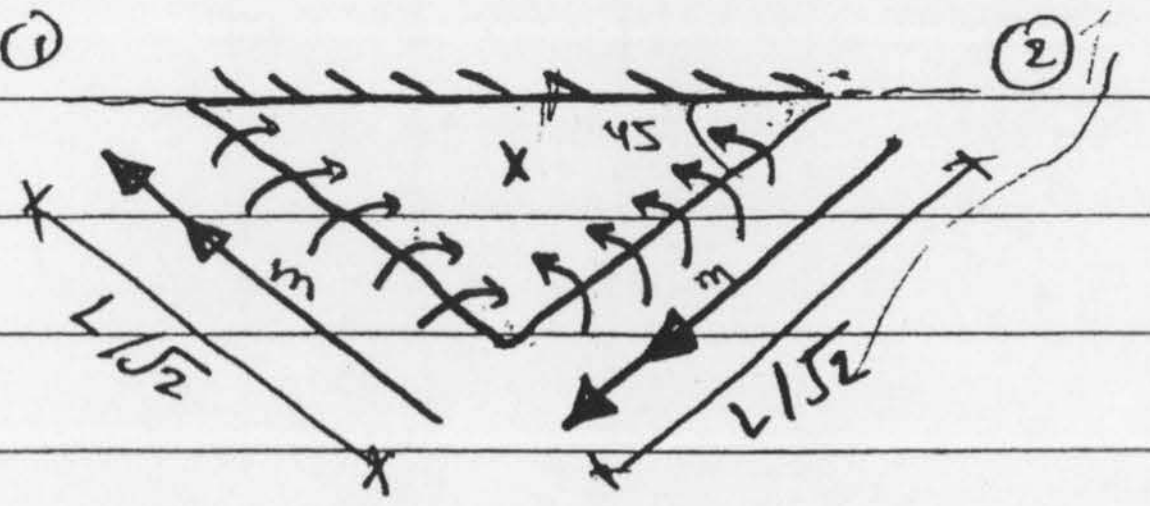
$b = 1000$

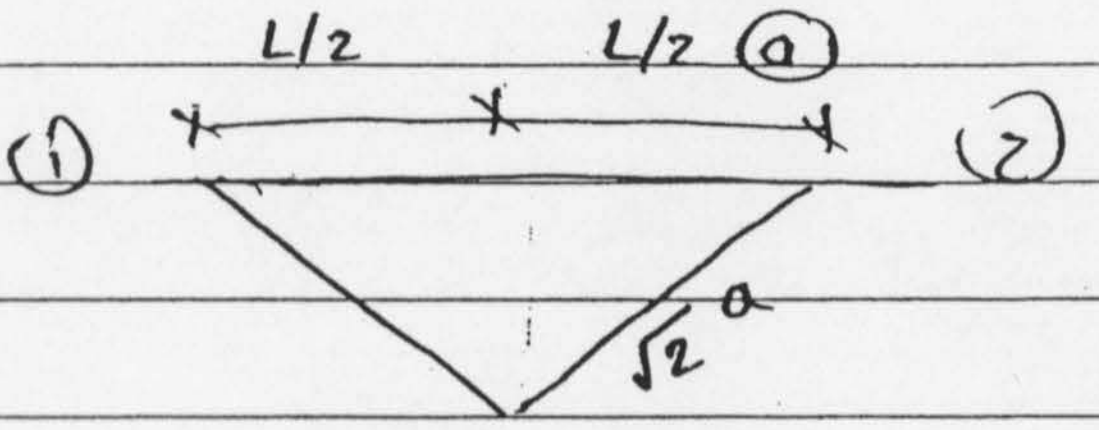
$d = t - 20 - db$

$$\rho = \frac{\frac{1000}{S} * Ab}{b d}$$

تقاطع محاور الدوران بالنص







ناخذ العزم (moment) حول المحور ① - ②

cos 45

(يحول من $\frac{kN}{m}$ الى kN.m)

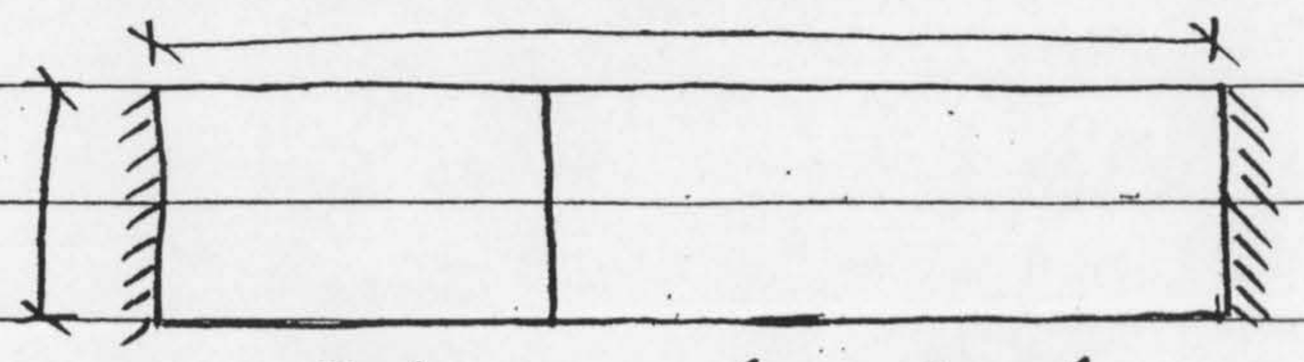
$$w l \cdot \frac{1}{2} l \cdot \frac{1}{3} * \frac{L}{2} = m \cdot \frac{L}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot 2$$

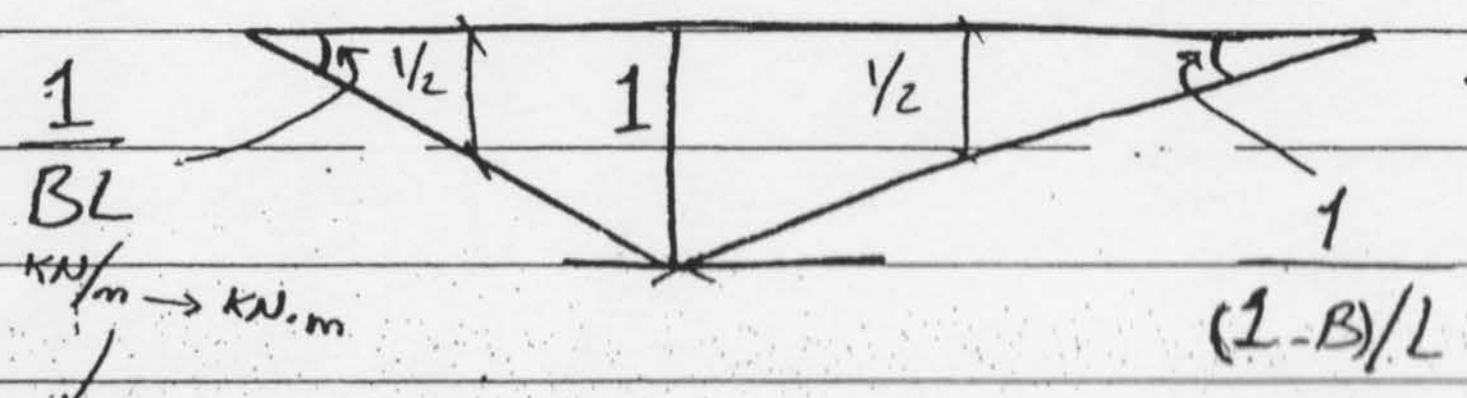
force

$$\therefore m = \frac{wL^2}{24}$$

Virtual work

Ex 8





$$E.W = wBL.(\alpha L).\frac{1}{2} + w(1-B)l.\ \alpha l.\frac{1}{2}$$

$$= wL.\alpha L.\frac{1}{2}$$

$$I.W = m.\alpha L\left(\frac{1}{BL}\right) + m.\alpha L\left(\frac{1}{(1-B)/L}\right)$$

$$W.E = W.I$$

$$w = \frac{2m}{L^2}\left(\frac{1}{\beta} - \frac{1}{\beta - 1}\right)$$

$$\frac{dw}{d\beta} = 0$$

$$\frac{2m}{L^2}\left(\frac{1}{-\beta^2}+\frac{1}{(1-\beta)^2}\right)=0 \qquad \beta=\frac{1}{2}$$

$$E.w = 2m\left(\frac{\alpha L}{2}\cdot\alpha L\cdot\frac{1}{2}\right)$$

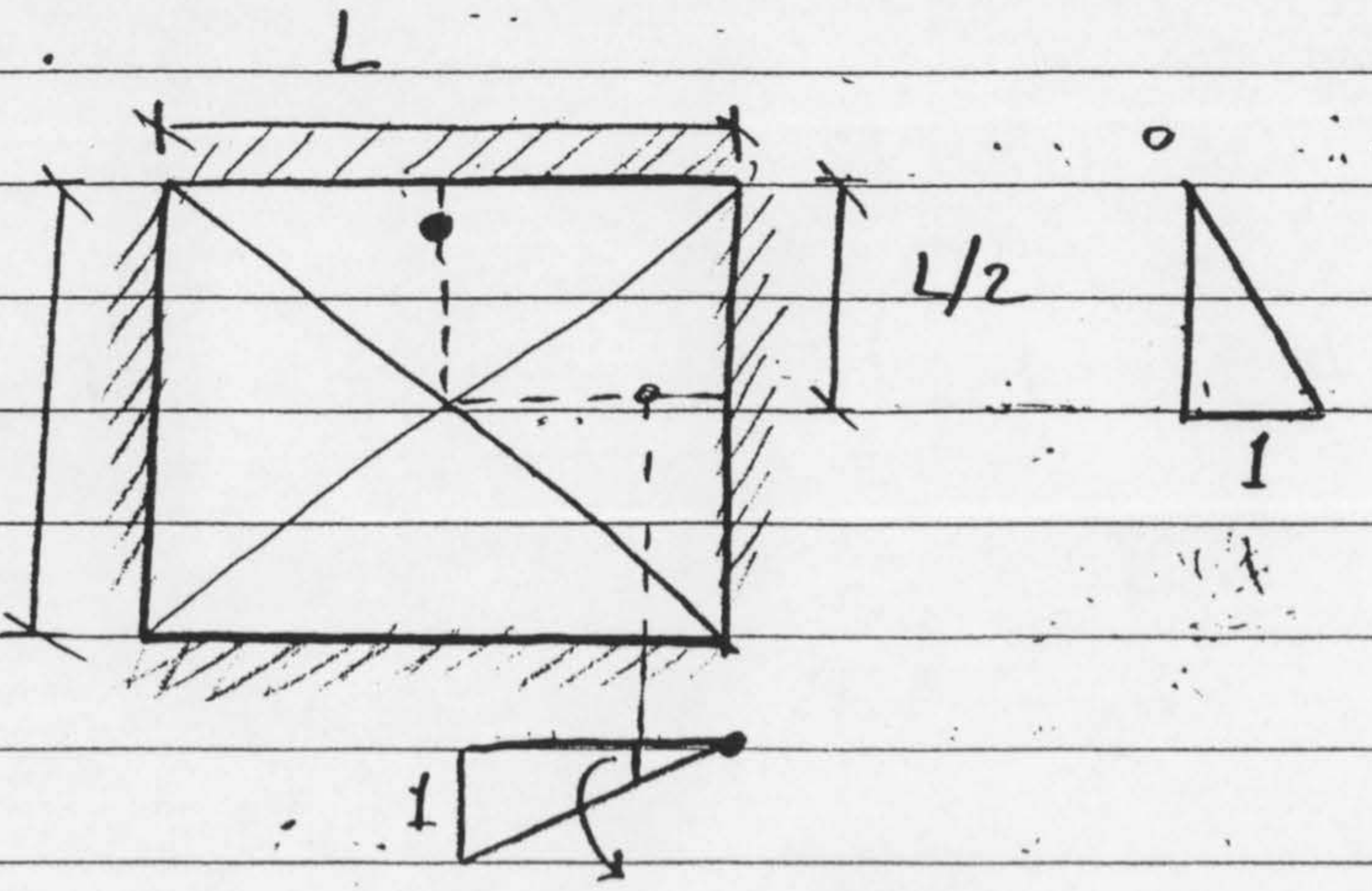
$$E.w = \frac{\alpha L 2}{2}$$

$$I.w = 2\left(m\cdot\alpha L\cdot\frac{2}{L}\right) = 4m\alpha$$

$$w = \frac{8m}{L^2}$$

+ امثلة بالملزمة.

Ex



$\frac{1}{3}$ من التشابه التناسب

٤ قطع

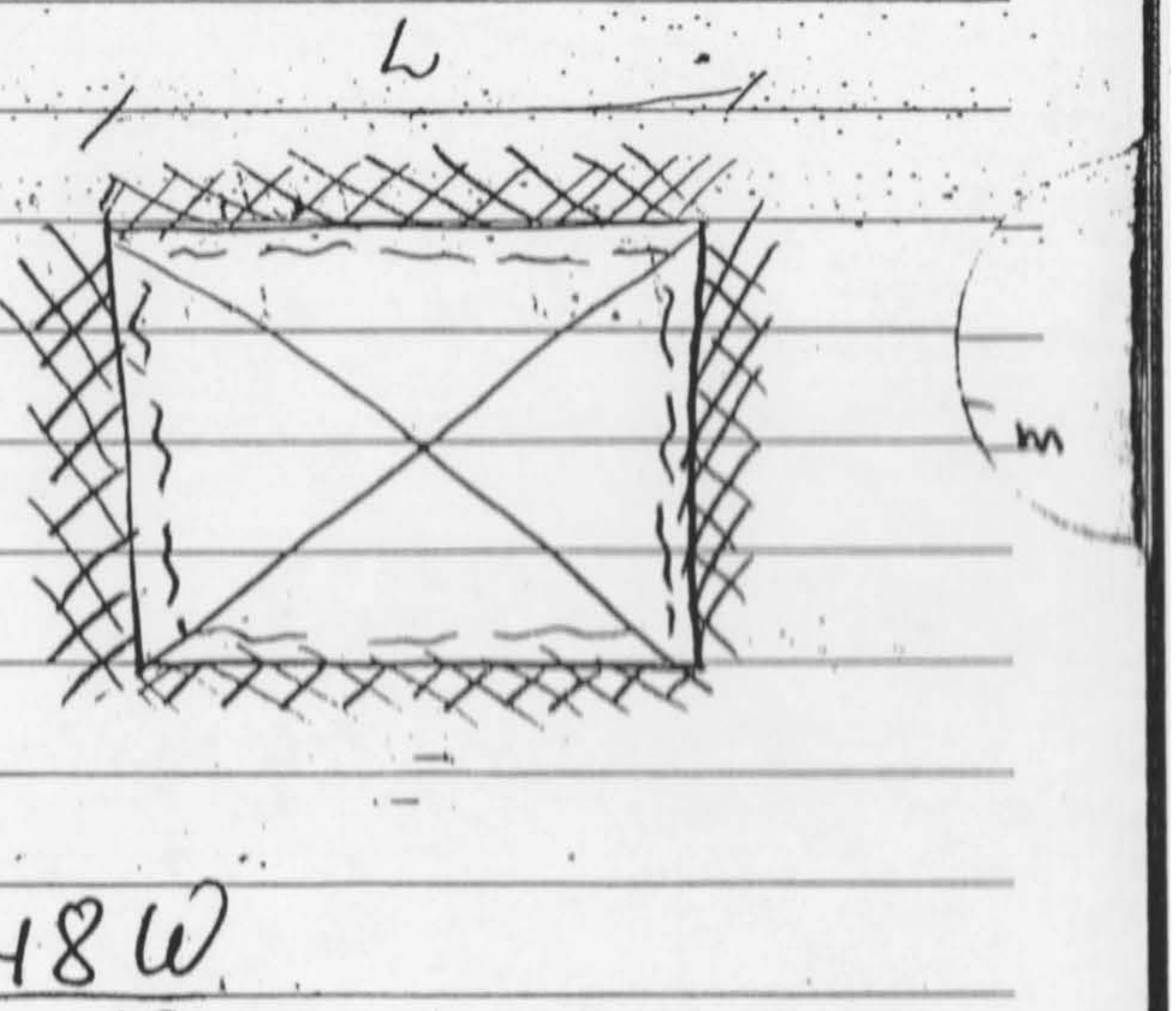
$$W.E = 4 \times W \times L \times \frac{L}{2} \times \frac{1}{2} \times \frac{1}{3} = \frac{WL^2}{3}$$

$$W.I = 4 \times m \times L \times \frac{2}{L} = 8m$$

$$\frac{WL^2}{3} = 8m$$

$$W = \frac{24m}{L^2}$$

Ex



$$W.E = \frac{WL^2}{3}$$ مسقط السالب هو نفسه (1) لأنه موجب دائماً

$$W.I = 4\left(mL \times \frac{2}{L} + mL \times \frac{2}{L}\right)$$

$$= 16m$$

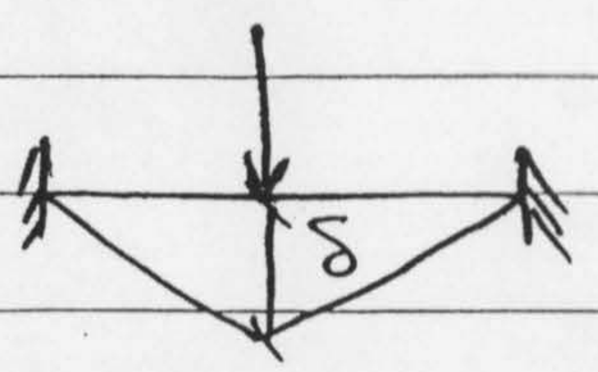
$$16m = \frac{WL^2}{3} \longrightarrow W = \frac{48W}{L^2}$$

(2) Virtual work الشغل الافتراضي

يعتمد على مبدأ $E.W = I.W$

$E.W = P.\delta$

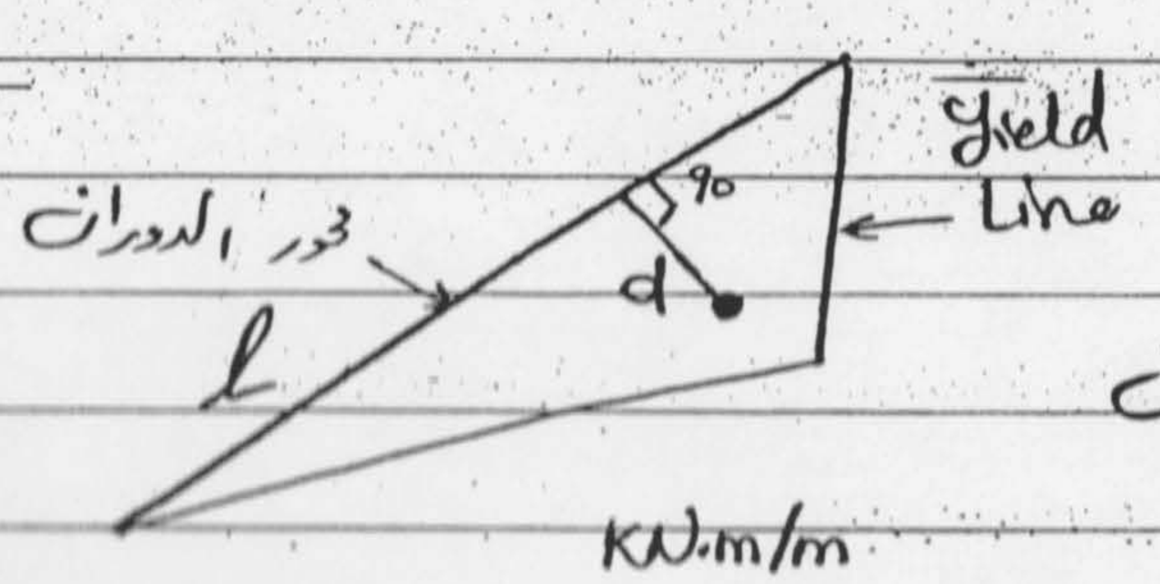
where δ (deflection under δ)



(or) $E.W = \underbrace{w.A}_{\text{force}}.\delta$

where δ (deflection under centroid of A)

$I.W$



منا أي نقطة معروفة بالمستوى تكون الـ (Yield Line)
لها معلوم deflection
نرسم خط مستقيم على محور الدوران.

KN.m/m

$$I.W = m.\overset{m}{L}.\frac{\delta}{d}$$

Where: δ: deflection at any point in segment
d: Perpendicular distance from the point of axis of rotation

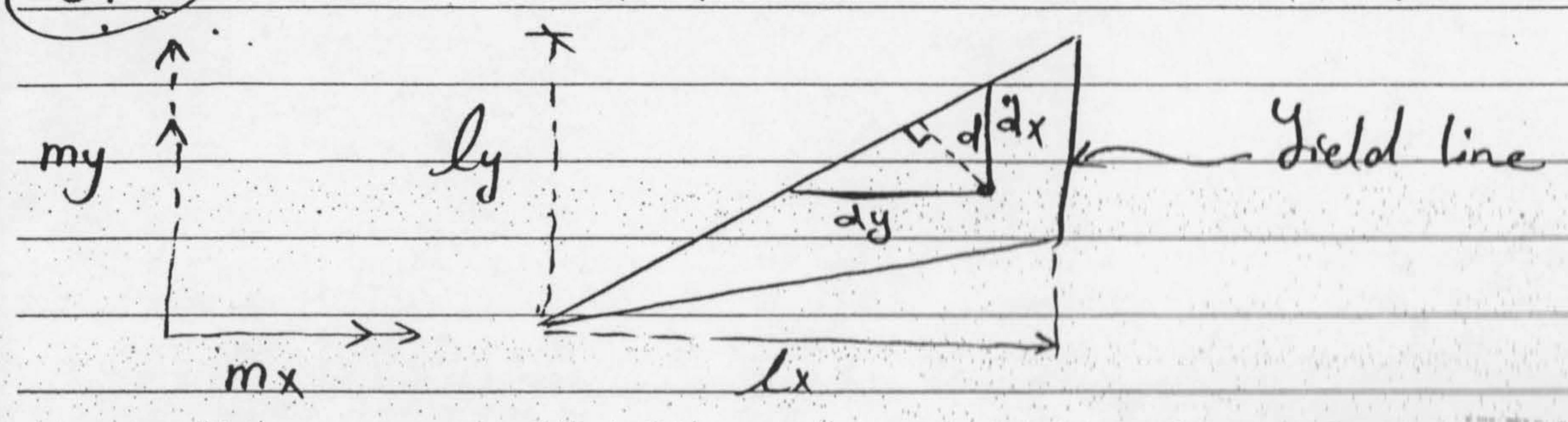
المسافة المعرفة العمودية الواصلة من نقطة معرفة الديفلكشن والعمودية على محور الدوران.

l: Projection of yield line on axis of rotation.

L : هو مسقط الـ Yield Line على محور الدوران.

* نلجأ الى هذه الطريقة في الحالات التالية ::
اما يكون محور الدوران مائل أو يكون الـ (Slab) orthotropics هو المستخدم

Or.



مسقط الـ Y.L على X اذا كان Postive أو Nega.

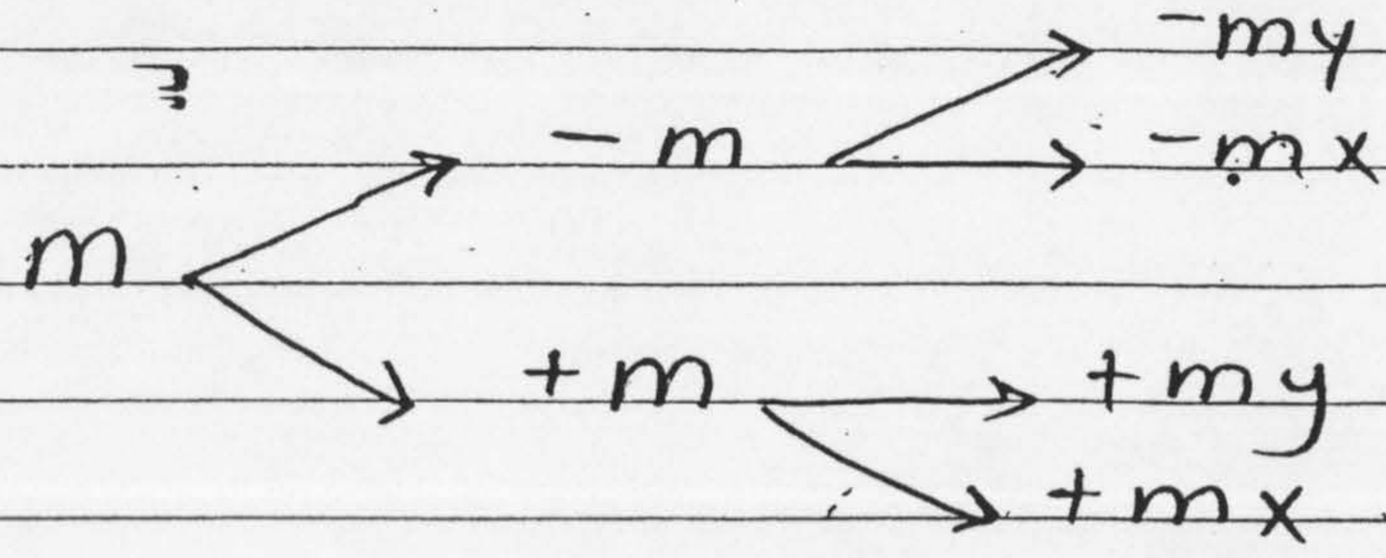
مسقط الـ Y.L على Y اذا كان Positive أو Negative

$$I.\omega = m_x . L_x . \theta_x + m_y . \theta_y . l_y$$

$$\theta_x = \frac{\text{deflection of any point in segment}}{\text{vertical distance from the point to axis of rotation}} = \frac{\delta}{dx}$$

بعد النقطة عن محور الدوران

$$\theta_y = \frac{\text{deflection of any point in segment}}{\text{horizontal distance from the point to axis of rotation}} = \frac{\delta}{dy}$$



(isotrophic)

$-m_x = -m_y$

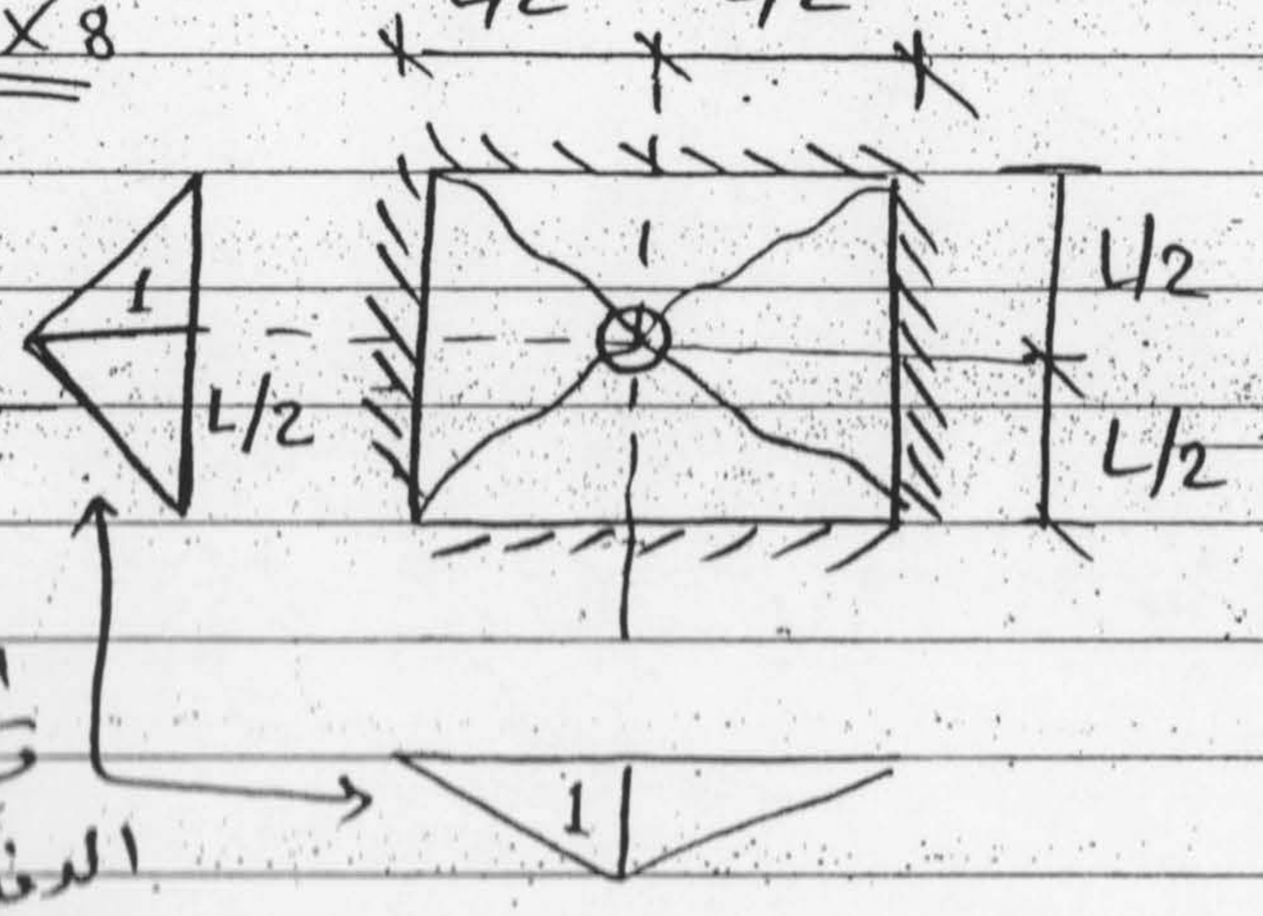
$+m_y = +m_x$

(orthrotropic)

$-m_x \neq -m_y$

$+m_x \neq +m_y$

Ex 8



(Point load) 0
عند Positive Yield line
فقط ماكو fixed
هنا يكون عند Negative

تنظر للشكل من الاعلى

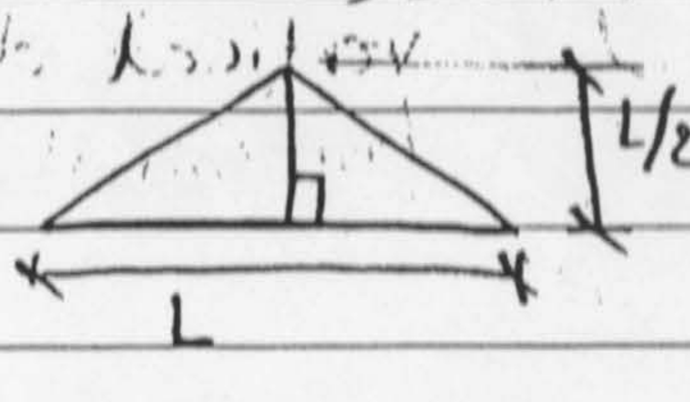
$E.W = P.1$

اربع جهات متساوية

$I.W = \underline{4} * m * l \frac{1}{l/2}$

$= 8m$

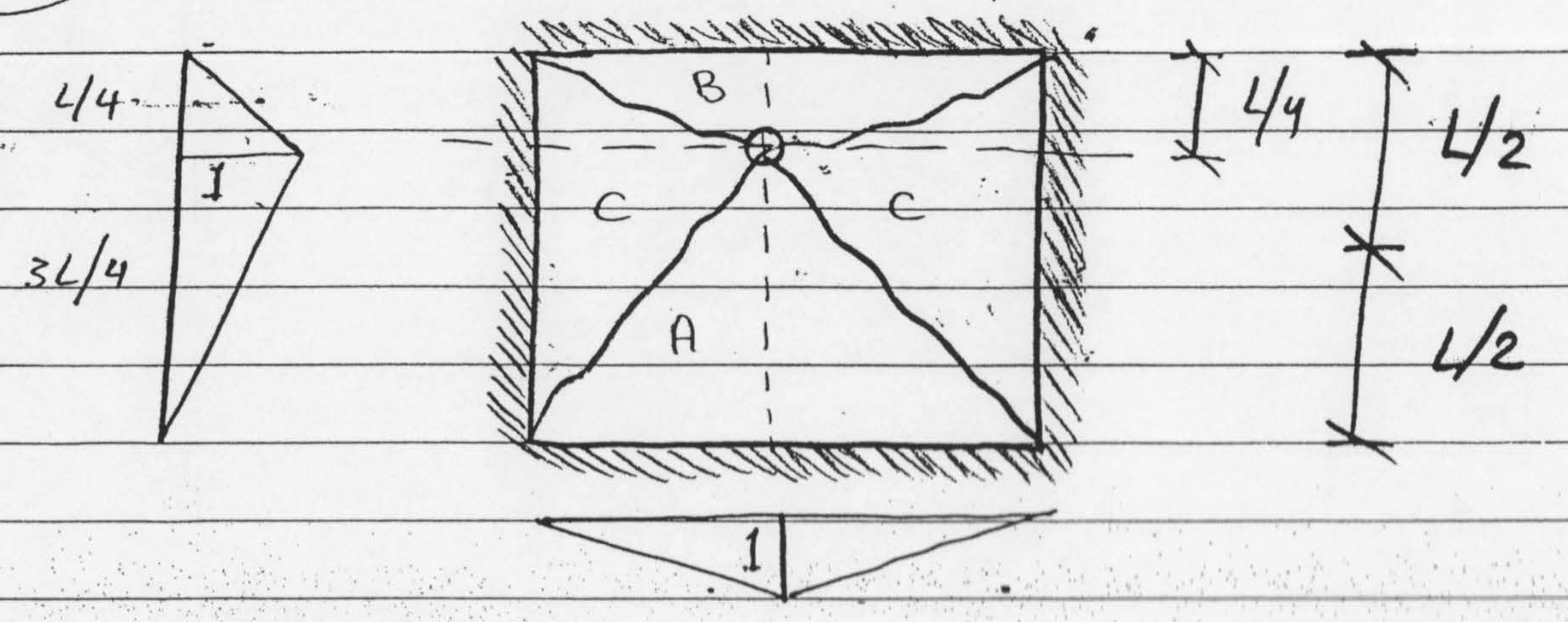
مثلا تقلهم معرفة الدفلكشن ترسم عمود على محور الدوران



$E.w = I.w$

$P.1 = 8m \Longrightarrow P = 8\,m$

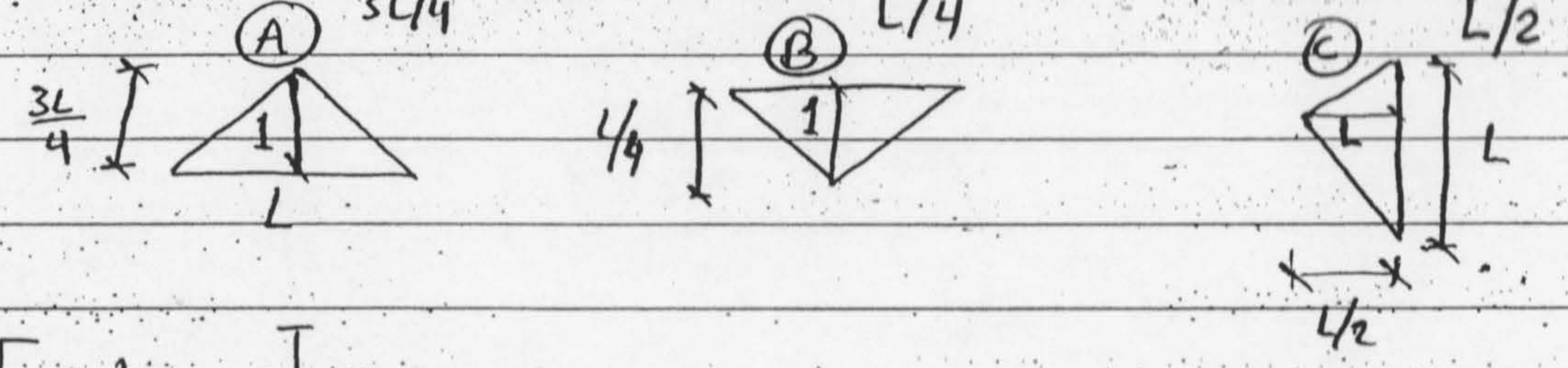
(Ex)



$E.w = P.1$

$4/3\,m + 4m + 4m = 9.333\,m$

$I.w = m.L.\frac{1}{3L/4} + m.L.\frac{1}{L/4} + 2\,m.L.\frac{1}{L/2}$



$E.w = I.w$

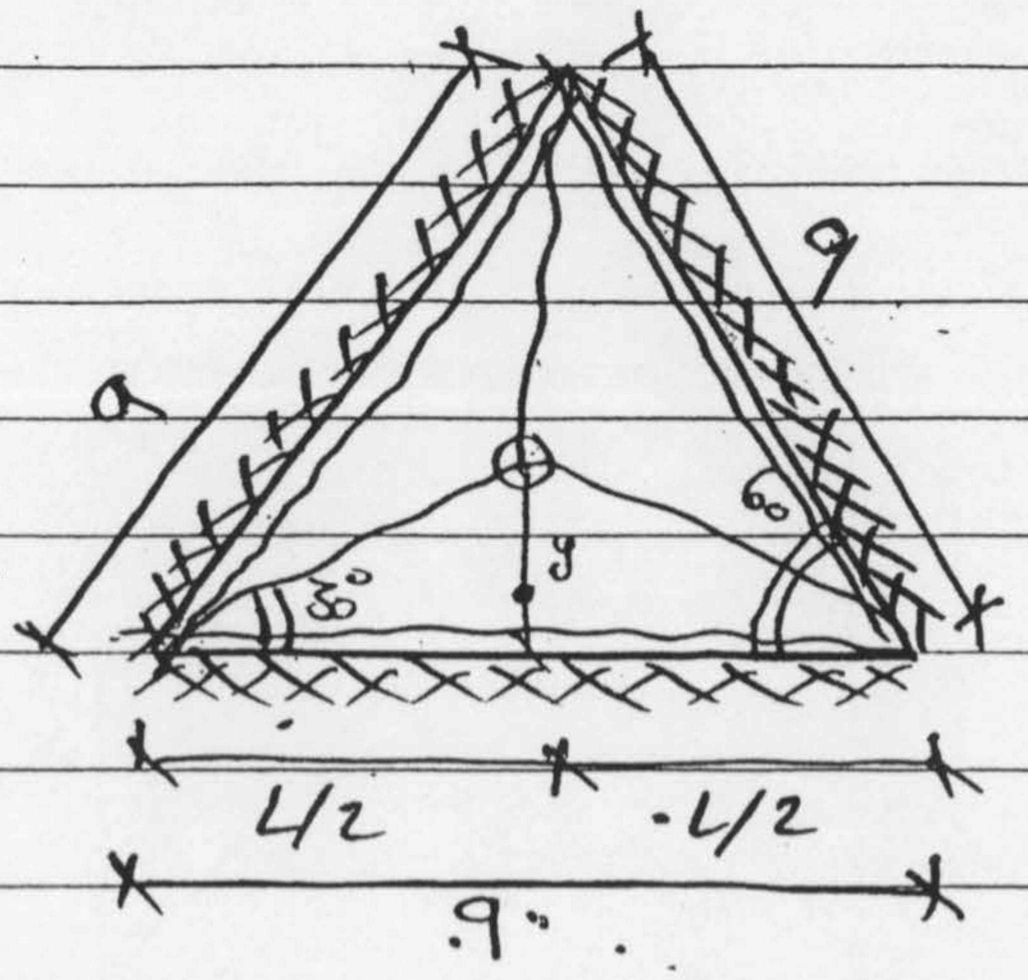
$P.1 = 9.333\,m$

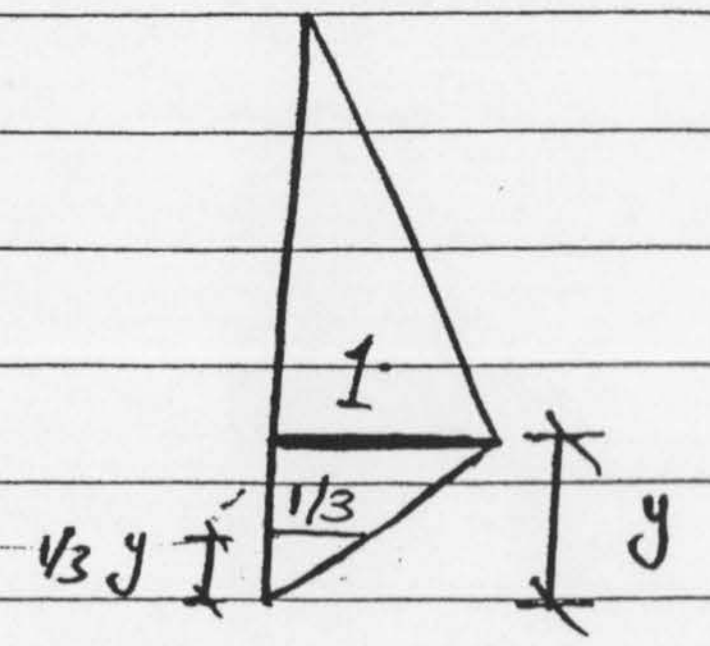
$\therefore P = 9.333\,m$

نلاحظ ان اللود كلما يكون بعيد عن المركز تزداد مقاومة للاحمال.

(Ex) $m^- = 2m$, $m^+ = m$

لازم تشبه عرقة
$-m$, $+m$
لان اكو
fixed





$\tan 30 = \frac{y}{4.5} \Longrightarrow y = \tan 30 * 4.5 = \frac{1}{\sqrt{3}} * 4.5 = 2.66$

$E.w = 3\left(w \cdot \underbrace{2.6 * 9 * \tfrac{1}{2}}_{\text{area of triangle}}\right) \cdot \left(\tfrac{1}{3}\right) = 11.7\, w$

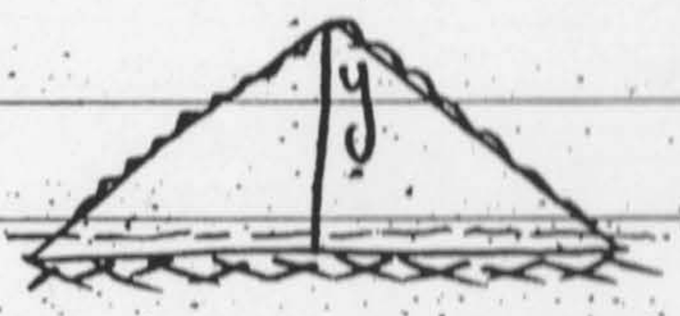
force

θ

$I.w = 3(m^+ \cdot l + 2m^- \cdot l) * \left(\frac{1}{y}\right)$

$= 3(3m \cdot 9) * \frac{1}{2.66}$

$= 31.15\, m$



$E.w = I.w$

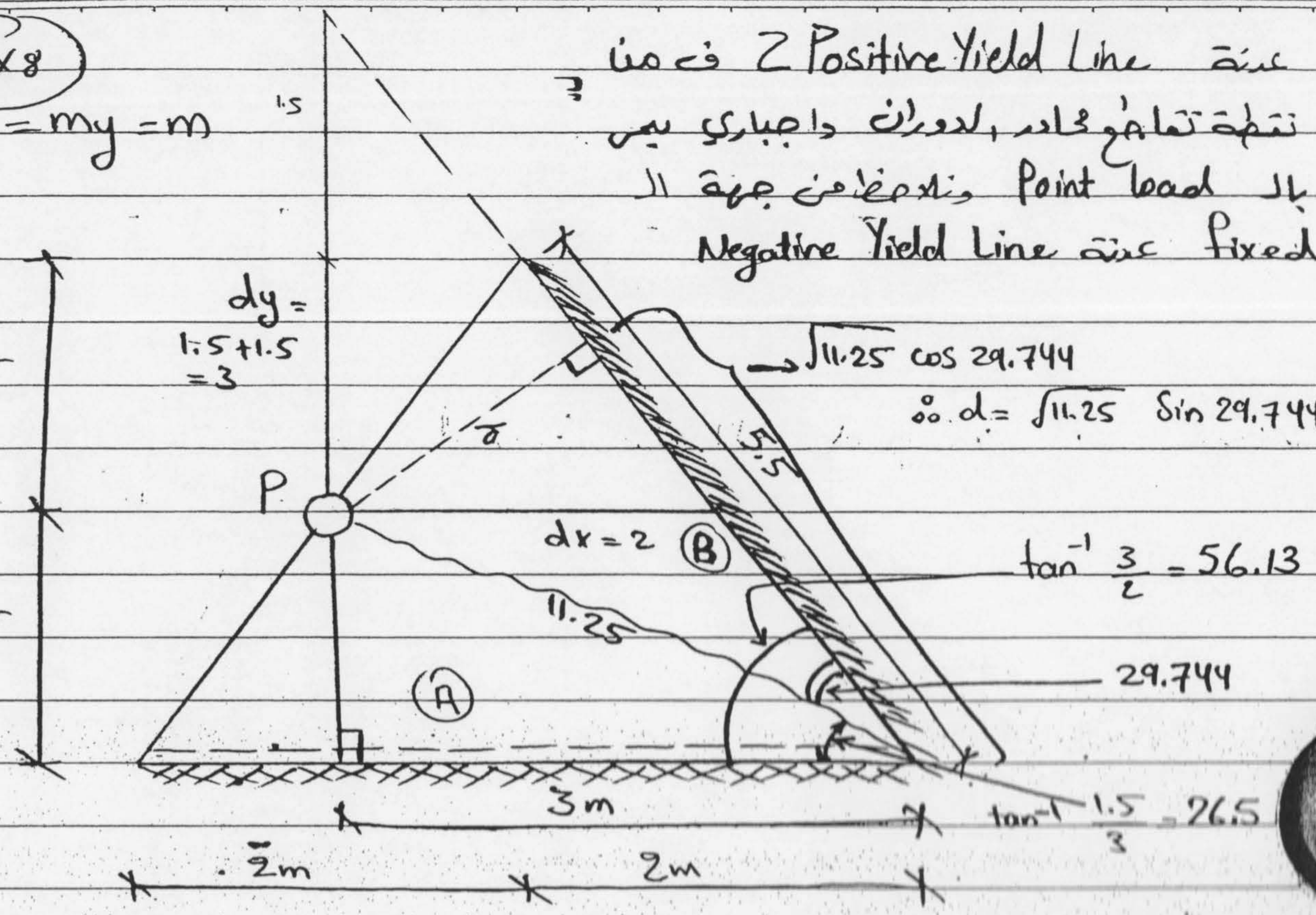
$11.7\, w = 31.15\, m$

$\therefore w = 2.66\, m$

Ex8

$m_x = m_y = m$

عندنا 2 Positive Yield Line في منطقة تقاطع محاور الدوران واجباري يمر بال Point load وكلامعطى من جهة ال fixed عندنا Negative Yield Line



E.w = P.1

$$I.w\ (A) = (m^{-}.4 + m^{+}.3)\left(\frac{1}{1.5}\right) = 4.666\ m$$

طول محور الدوران السالب — طول محور الدوران الموجب (المسقط)

$$I.w\ (B) = m\sqrt{1.125}\cos 29.744 \cdot \frac{1}{\sqrt{11.25}\sin 29.744} = 1.75\ m$$

or

لازم تكلمة dy و dx من تشابه المثلثات

$$I.w\ (B) = m.1.5 \times \frac{1}{2} + m.3 \cdot \frac{1}{3} = 1.7\ m$$

موحتر يعني moment

$P = 4.666\,m + 1.75 = 6.41\,m$

(or) $I.\omega (B) = (m^{+} 1.5 + m^{-} . 3)(\frac{1}{2}) + [m^{+} x + m^{-} x_2] . \frac{1}{3}$

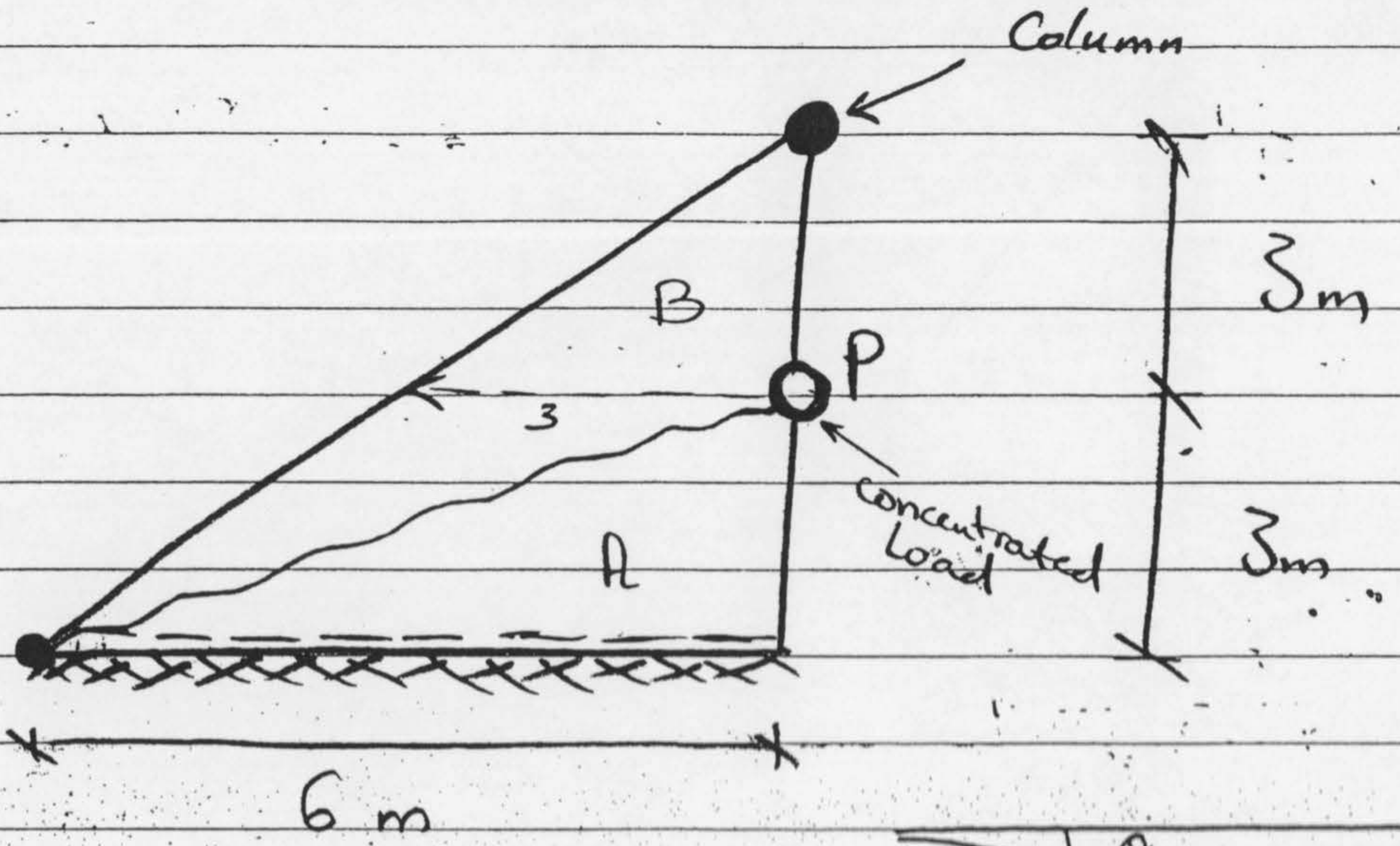
I.ω(B) اذا كان عندنا fixed بدل ال hinged الـ
يكون كالتالي :-

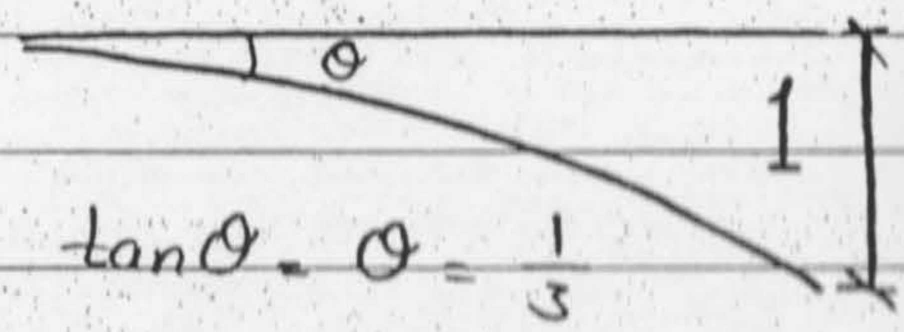
$$I.\omega (B) = \left[m . \sqrt{11.25} \cos 29.744 + 5.5\,m \right] . \frac{1}{\sqrt{11.25} \sin 29.744}$$

29/2/2016

الموضوع :   التاريخ   /   /   ٢٠

Ex 9   * حالة ال free end أو Cantilever محور الدوران يدور 360° فى الامتحان يحدد محور الدوران





$\tan\theta = \theta = \frac{1}{3}$

$E.W = P.1\ \theta$

$I.W\ (A) = (6m^{+} + 6m^{-})\frac{1}{3} = 4m$ ستقيط ال Y.L على ال x وال y

$I.W\ (B) = 6m^{+}\frac{1}{3} + 3m^{-}\frac{1}{3} = 3m$

$E.W = I.W$

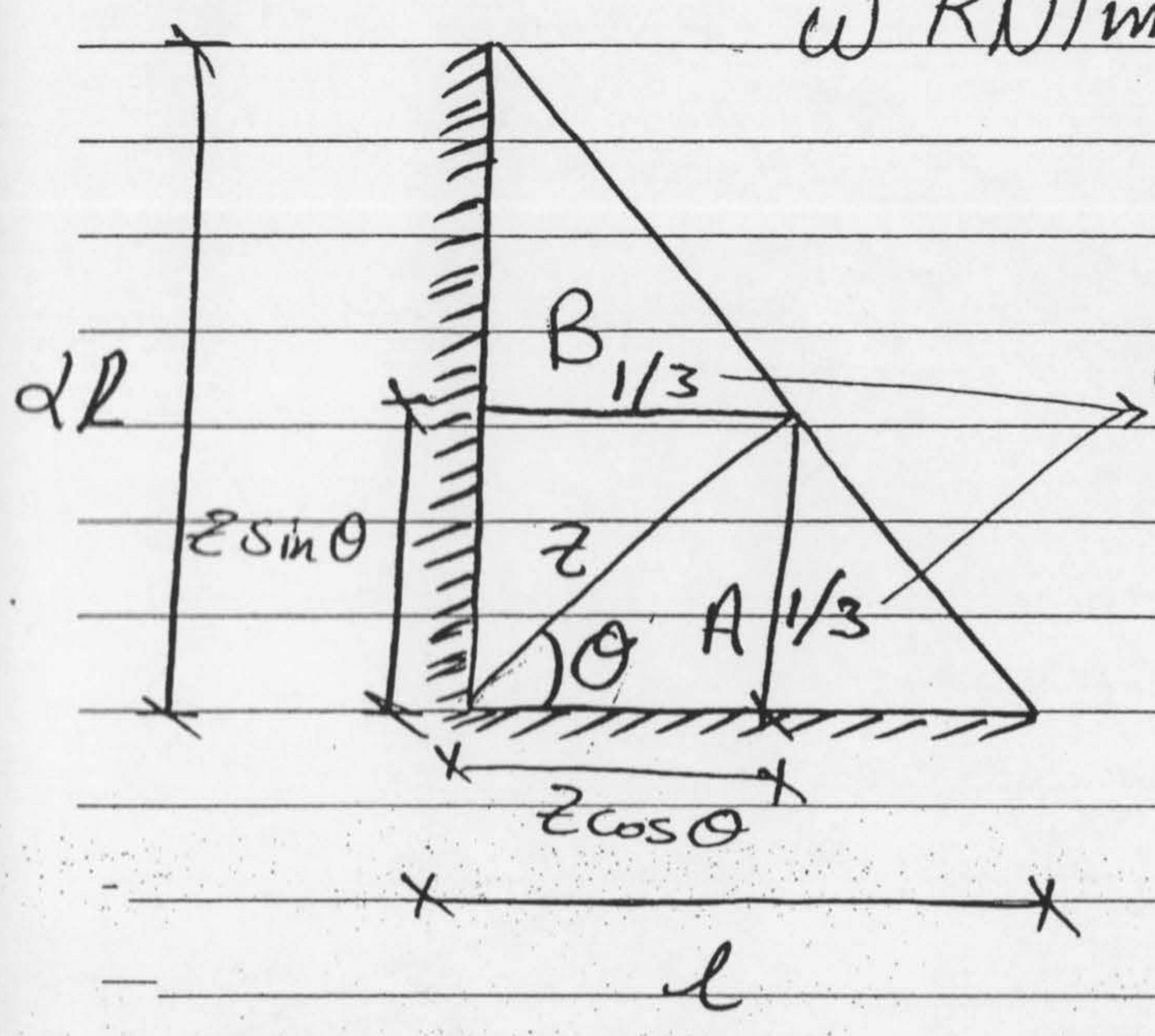
$P.1 = 7m$

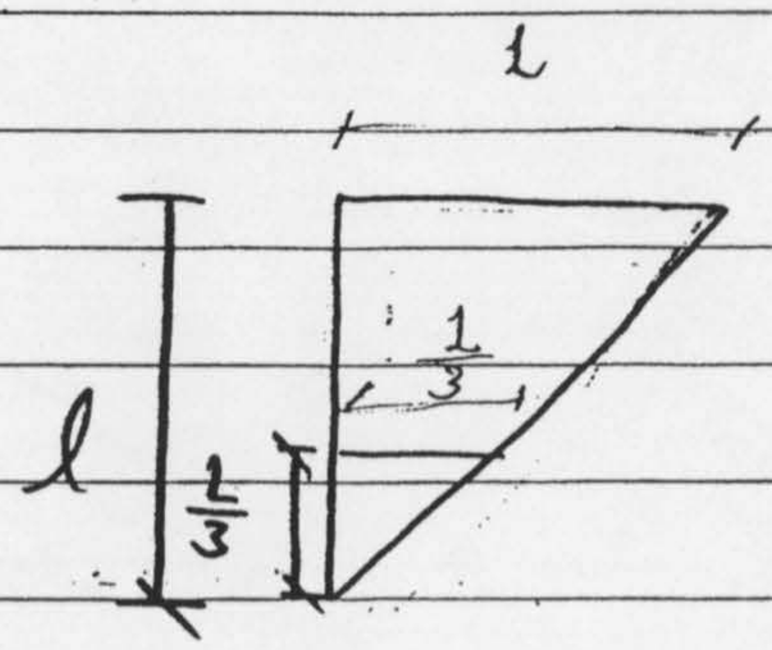
$P = 7m$

Ex 8 لازم ننتبه ان الـ ω (الحمل) معطى و الـ (m) مجهول.

$\omega\ KN/m$

نفرض طول الـ L = Z
والزاوية مجهولة θ





$E.W = \omega . A_A . \delta_A + \omega . A_B . \delta_B$

$= \omega A_A \times \frac{1}{3} + \omega A_B \times \frac{1}{3}$

$= \omega \frac{1}{3} (A_A + A_B)$ ← مساحة المثلث

$= \omega \frac{1}{3} (\alpha L \times L \times \frac{1}{2})$

$= \frac{\alpha \omega l^2}{6}$

(A) (B)

$I.W = m Z \cos\theta \times \frac{1}{Z \sin\theta} + m Z \sin\theta \times \frac{1}{Z \cos\theta}$

$$= m \frac{\cos\theta}{\sin\theta} + m \frac{\sin\theta}{\cos\theta}$$

$$= m \left(\frac{\cos^2\theta + \sin^2\theta}{\sin\theta\cos\theta} \right) \quad (\cos^2\theta + \sin^2\theta = 1)$$

$$I.W = \frac{m}{\sin\theta\cos\theta}$$

$$I.W = E.W$$

$$\alpha \frac{WL^2}{6} = \frac{m}{\sin\theta\cos\theta}$$

$$m = \alpha \frac{WL^2}{6} \sin\theta\cos\theta$$

نشتقها ونساوي للصفر

$$\frac{\partial m}{\partial \theta} = \frac{\alpha WL^2}{6} (-\sin\theta\sin\theta + \cos^2\theta)$$

$$0 = \cos^2\theta - \sin^2\theta$$

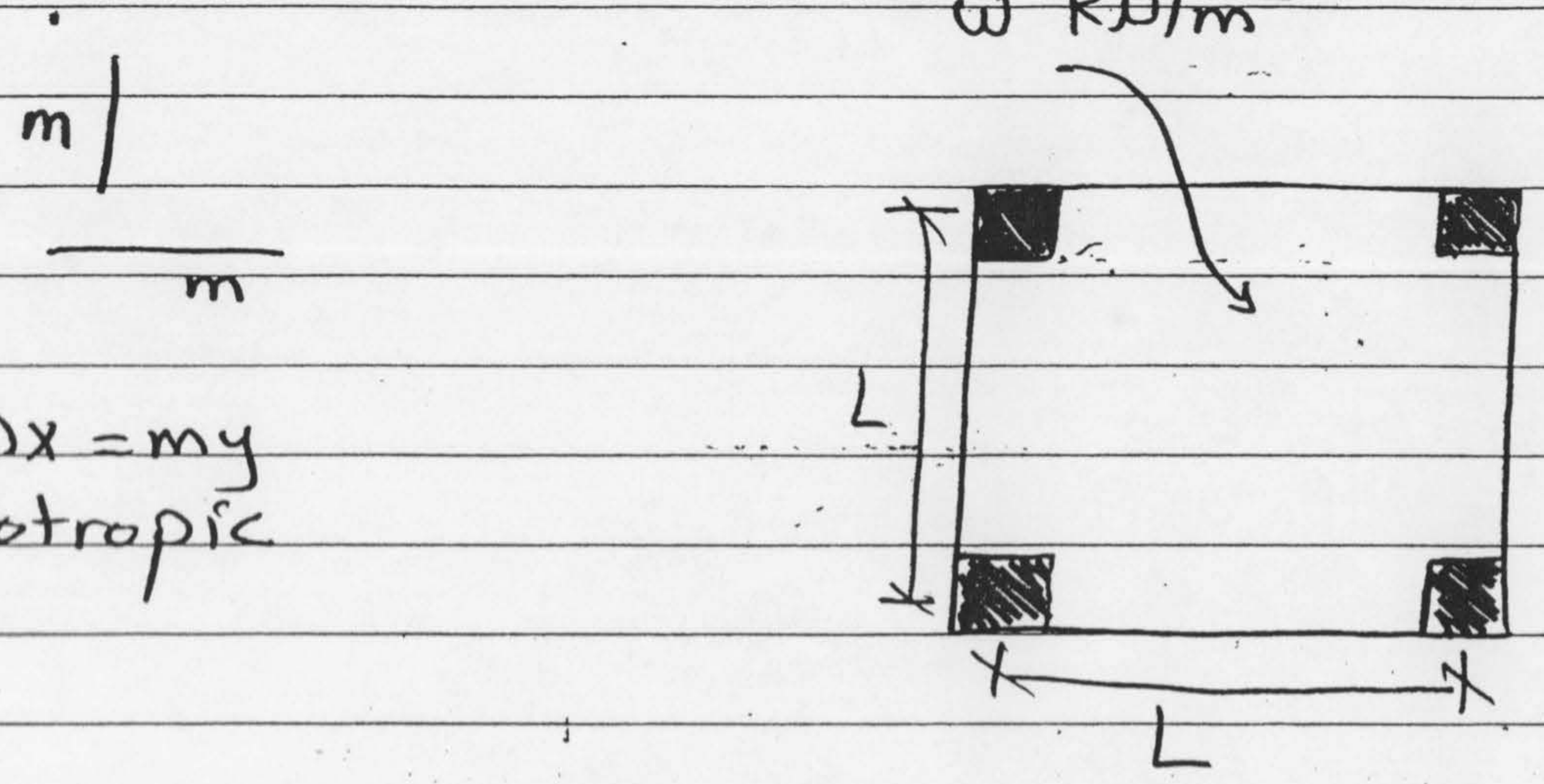
$$\cos^2\theta = \sin^2\theta$$

$$\tan^2\theta = 1 \Longrightarrow \theta = 45$$

من هنا
سعيد → 12/4/2016

الموضوع :   التاريخ / / ٢٠

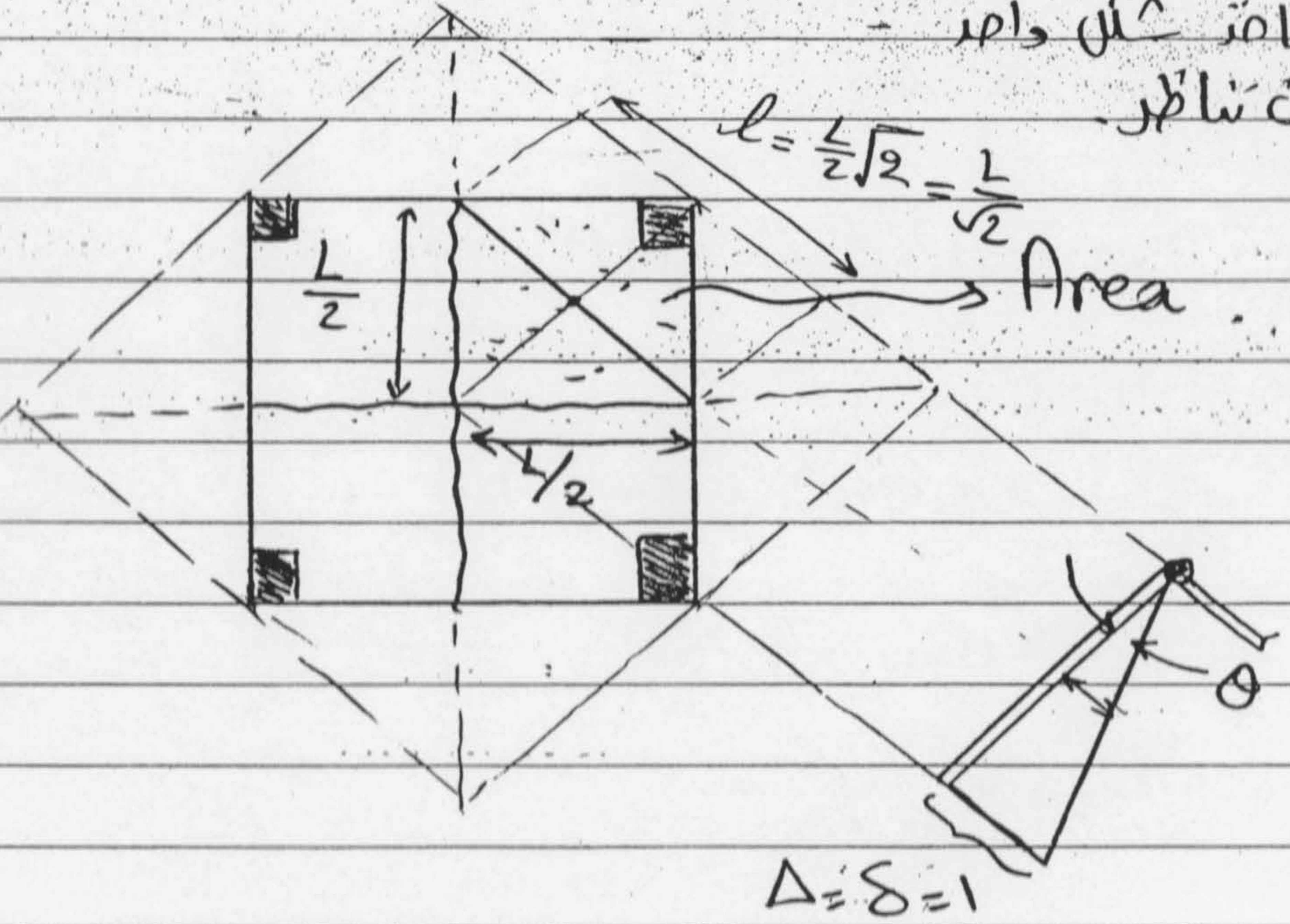
Ex Find the relation between ω & m



∴ mx = my
isotropic

اذا أردنا ايجاد محور الدوران نفرض وجود كولوم واحد مستند عليه الشكل ومنه نعرف محور الدوران

* ناخذ شكل واحد
لان تناظر



$WI = m * l * \theta$

(− / +)

$WE = \underset{KN}{load} * \delta^{*}$

مقدار الهبوط تحت نقطة اللود

$WI = m_x l_x \theta_x + m_y l_y \theta_y$

٤ اجزاء

$WI = m * l * \frac{1}{l} * 4 = 4m$

٤ اجزاء — مساحة المربع كله

$WE = w * A * \frac{1}{2} * 4 = \frac{w}{2}(4A)$

$= \frac{wL^2}{2}$

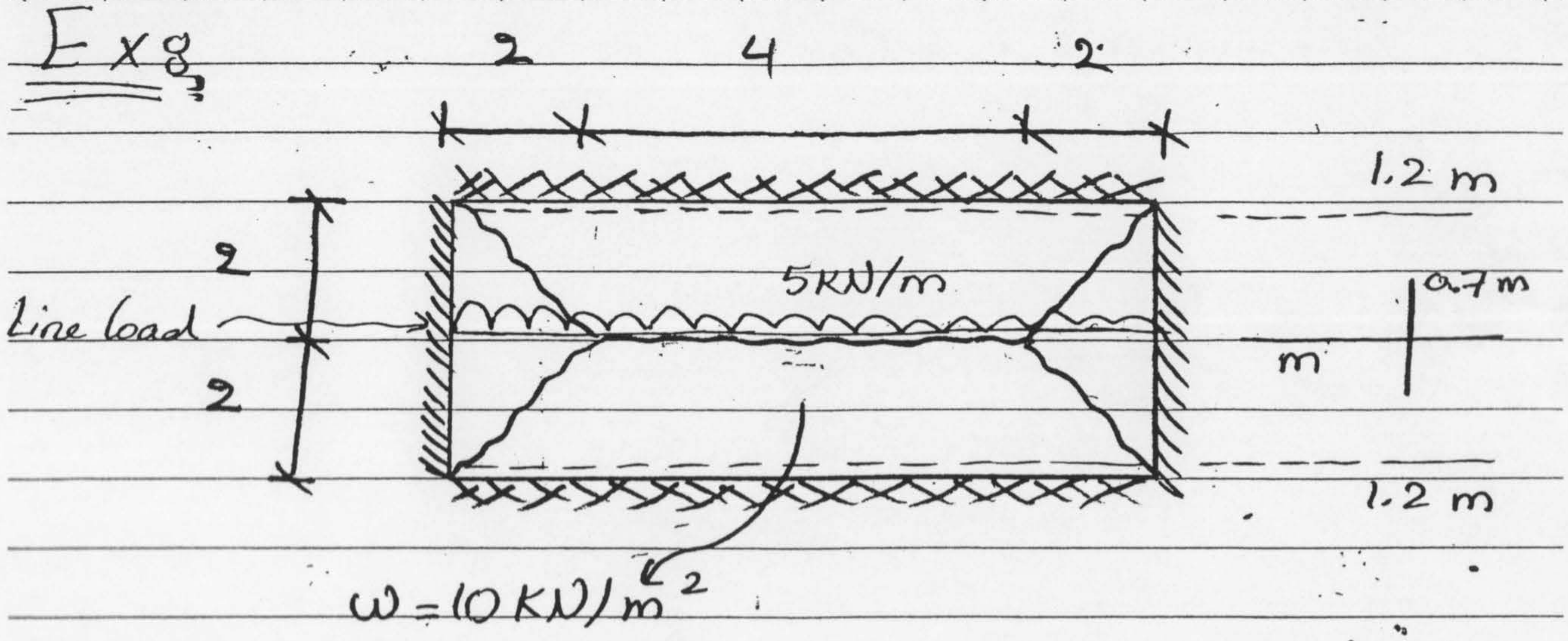
$WI = WE$

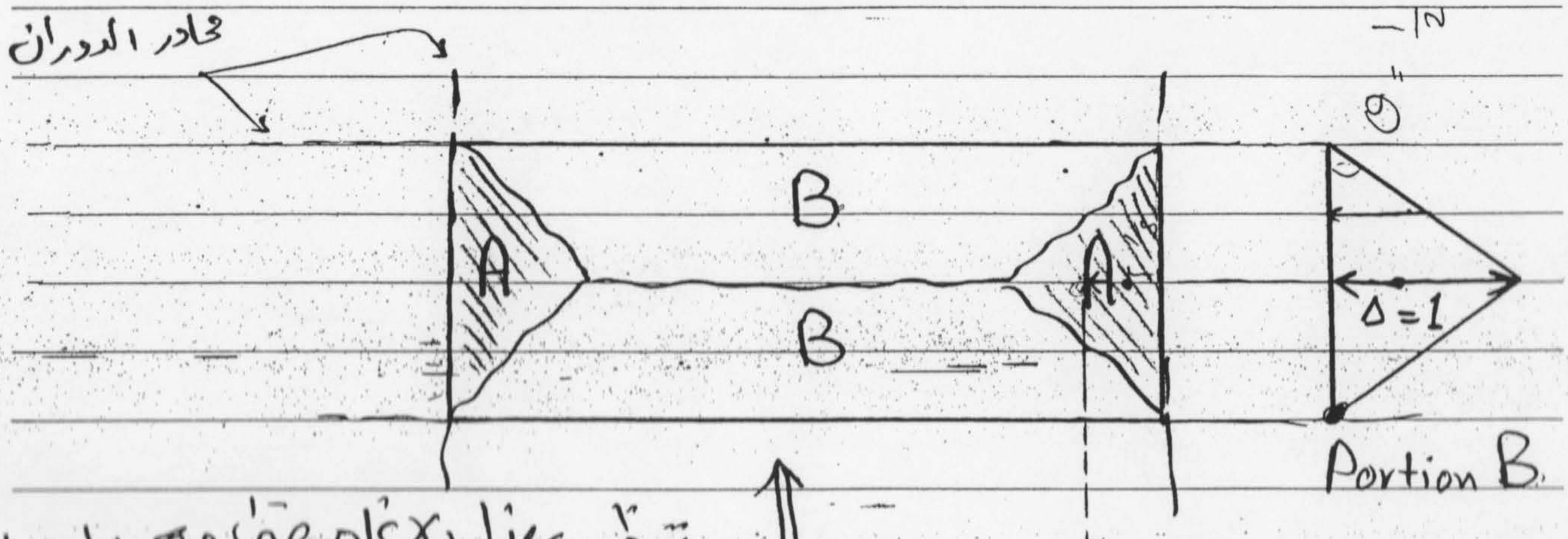
$4m = \frac{wL^2}{2}$

$$m = \frac{wL^2}{8}$$

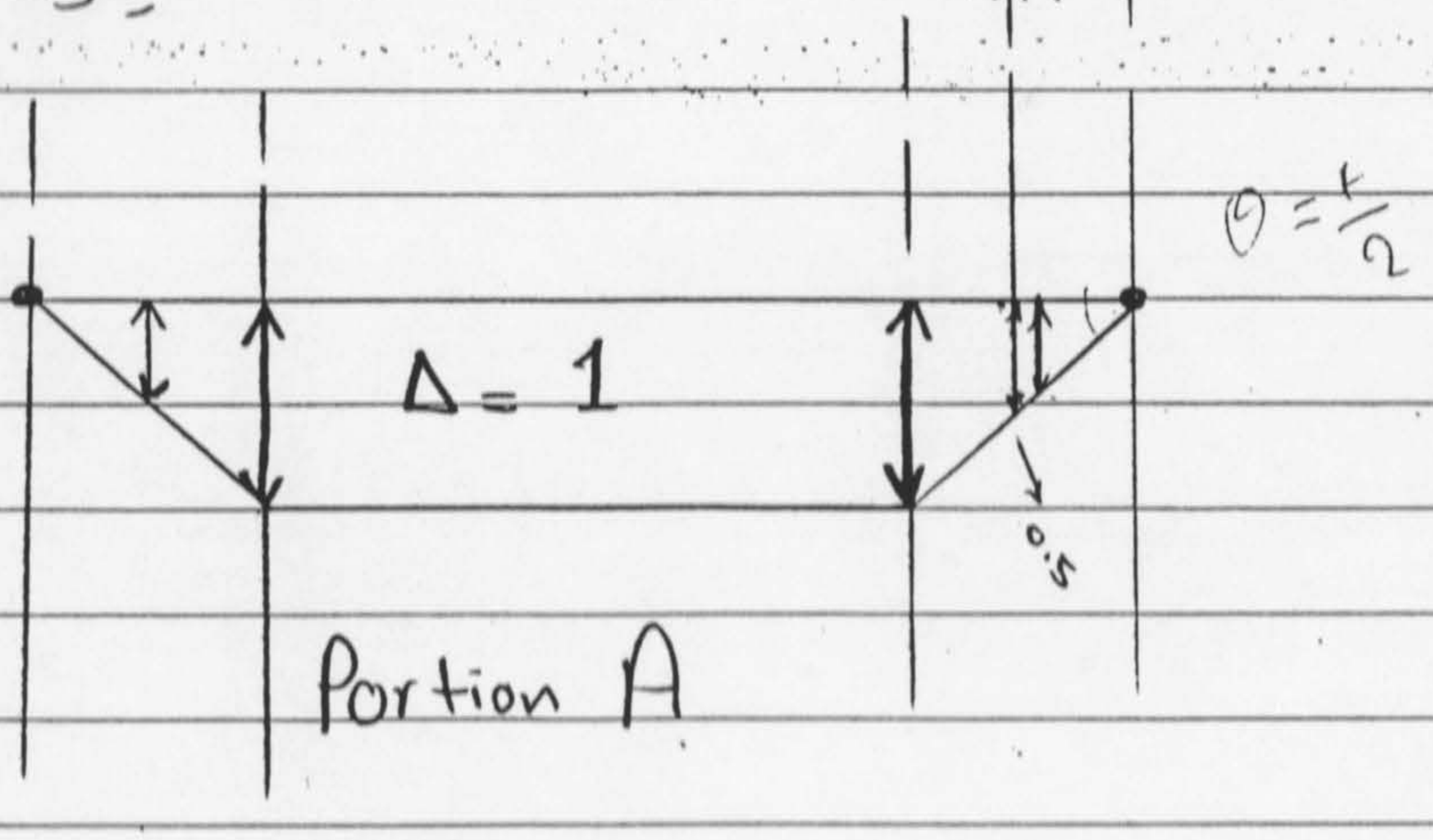
وحداته KN.m/m

Ex 8





تترض بهذا الاتجاه حتى محور الدوران يكون نقطة.



$w * A * \delta$ — جزئين

$$W.E)_{uniform} = 10 * \frac{4*2}{2} * \frac{1}{3} * 2 + 2\left[\underset{w\ A}{10*4*2} * \frac{1}{\underset{\delta}{2}} + \underset{w}{2*10} * \frac{2*2}{2} * \frac{1}{3}\right]$$

$$= 10\left[\frac{8}{3} + 8 + \frac{8}{3}\right] = \frac{400}{3}$$

(مطول حمولة الـ line load بالمنتصف) (مطولة بالمنتصف) جزئين

$$WE)_{Line} = \underset{w}{5}*4*1 + \left[5*2*\frac{1}{2}\right] * 2$$

$$= 30 = \frac{90}{3}$$

$$WE)_{total} = \frac{400}{3} + \frac{90}{3} = \frac{490}{3}$$

$$W.I = \left[m * 8 * \frac{1}{2} + 1.2\,m * 8 * \frac{1}{2}\right] * 2 \rightarrow \text{جزئين}$$

$$+$$

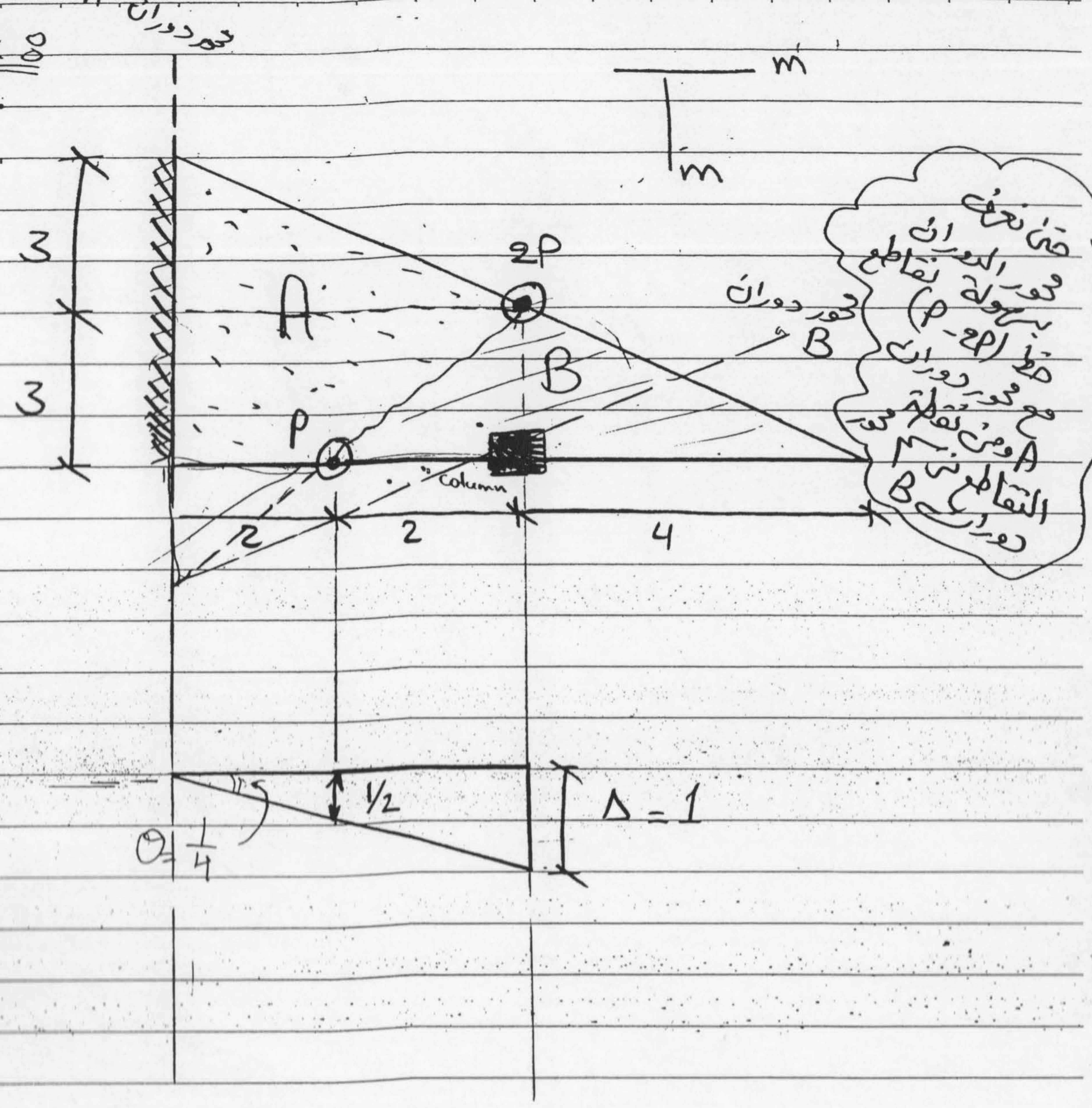
$$\left[0.7\,m * 4 * \frac{1}{2}\right] * 2$$

$$= \text{—}\ m$$

$$W.I = W.E$$

$m =$ —

Ex 8


A
محور دوران
m
m
3
3
2P
A
P
محور دوران
B
B
column
2
2
4
1/2
Δ = 1
θ = 1/4
متى نعرف
محور الدوران
بسهولة تقاطع
(P - 2P)
مع محور دوران
وهي نقطة
A
التقاطع
محور دوران B

$$WE = 2P * 1 + P * 1/2 = 2.5\ P$$

$$WI)_A = m * 3 * \frac{1}{4} + m * 6 * \frac{1}{4} = 2.25\ m$$

$$WI)_B = m_x L_x \theta_x + m_y L_y \theta_y$$

$$\frac{\text{مقدار هطول اي نقطة}}{\text{المسافة العمودية}} = \theta_y \quad , \quad \frac{\text{مقدار هطول اي نقطة في القطعة}}{\text{المسافة الشاقولية من هذه النقطة الى محور دوران النقطة اللي نشتغل بيها}} = \theta_x$$

$$\frac{1/2}{2} = \qquad \frac{1}{3} =$$

L = هو مسقط القطعة على محور x .X

$$= m * 2 * \frac{1}{3} + m * 3 * \frac{1/2}{2}$$

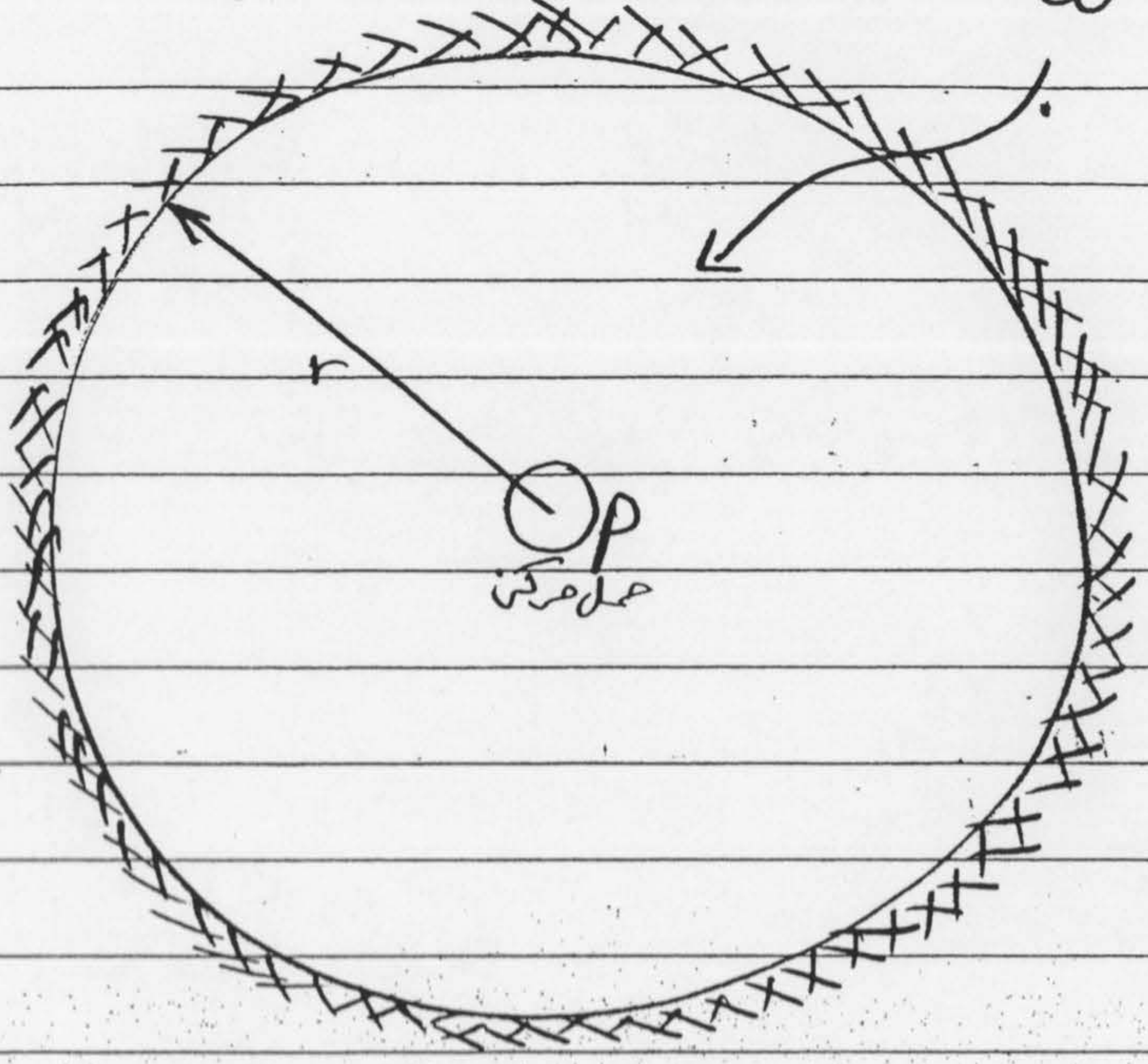
$$WI)_{total}$$

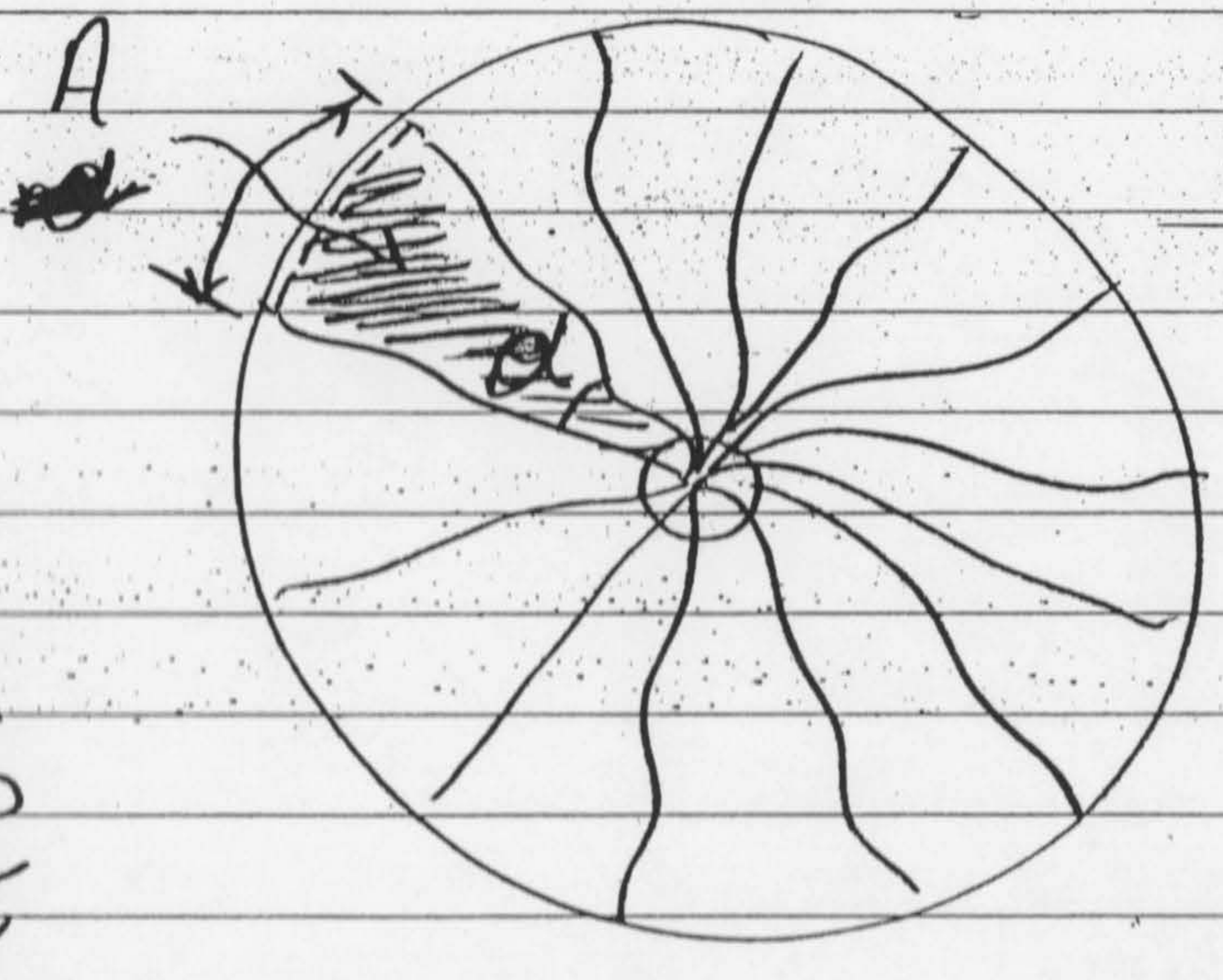
$$WI = WE$$

نجد علاقة بين m و P

Ex 8

m^+ , m^-





هطول المركز
مقدار كه واحد
واذا اعتبرنا
الشكل المظلل
هو مثلث مُهطولة
يكون على بعد
$\frac{1}{3}$

$$WE = P * 1 + \underset{kN/m^2}{w} * \underset{m^2}{A} * \frac{1}{3} * n$$

$$WE = P + \frac{w}{3}(nA)$$

$$\boxed{WE = P + \frac{w}{3}\pi r^2}$$

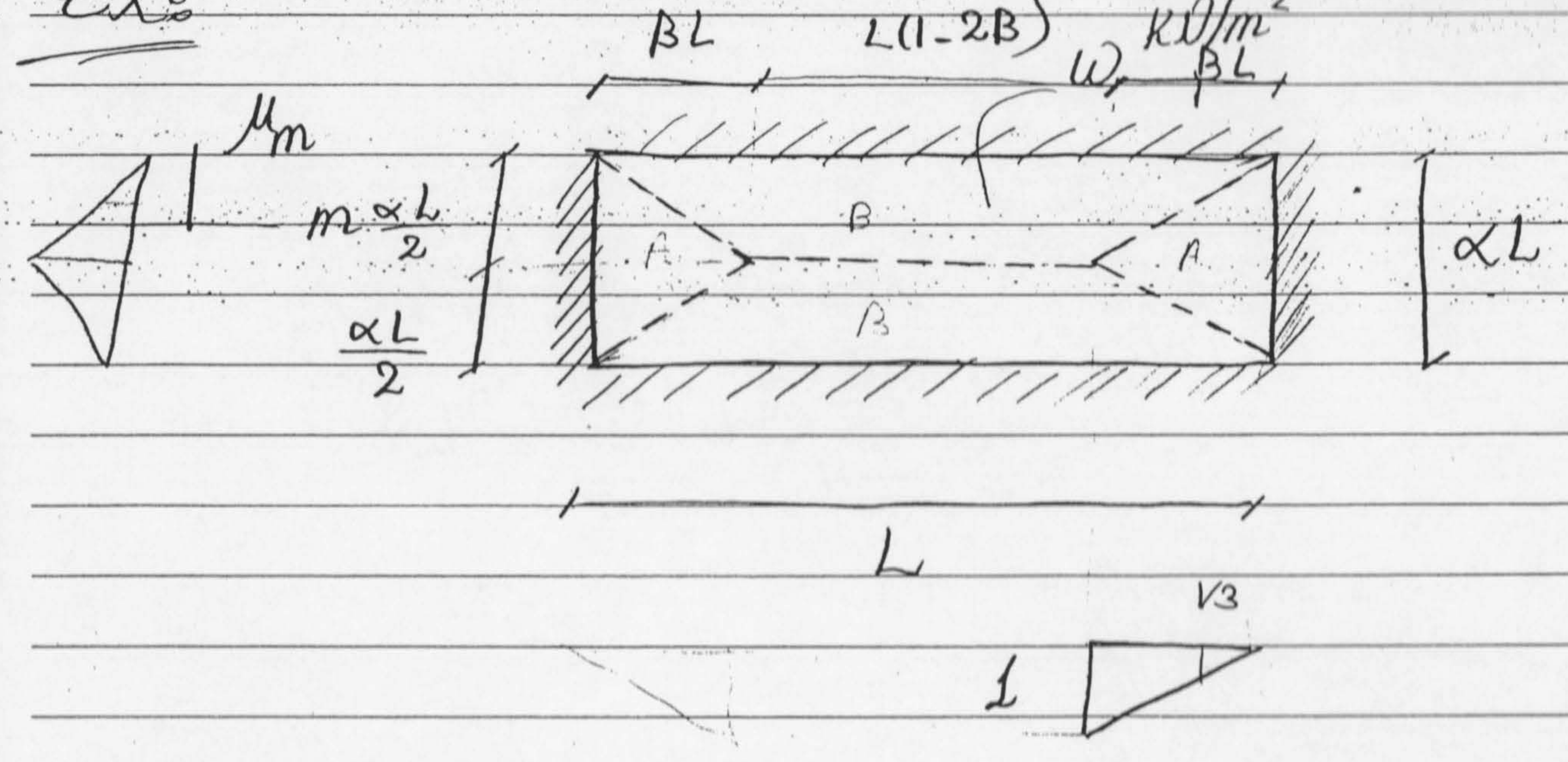
زاوية دوران المثلث

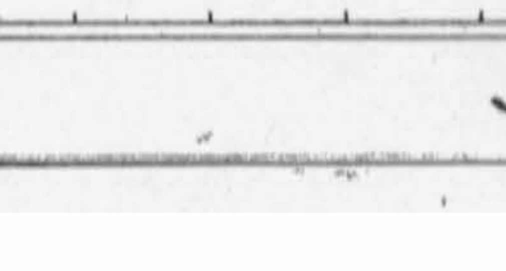
$$WI = (m^+ + m^-) * r\alpha * \left(\frac{1}{r}\right) * n$$

$$= (m^+ + m^-)\, 2\pi \longrightarrow 360\ (2\pi)$$ مجموع زوايا الدائرة

$$P + \frac{w}{3}\pi r^2 = (m^+ + m^-)\, 2\pi$$

Ex:





Winner Line

$$W.E = \left(W \times \frac{\alpha L}{2} \times BL \times \frac{1}{3}\right) \times 2$$

$$+$$

$$\left[W \times L(1-2B)\frac{\alpha L}{2} \times \frac{1}{2}\right] \times 2$$

$$+$$

$$\left[W \times \frac{BL}{2} \times \frac{\alpha L}{2} \times \frac{1}{3}\right] \times 4$$

$$W I = \left(m \times L \times \frac{1}{\left(\frac{\alpha L}{2}\right)}\right) \times 2$$

$$+$$

$$\left(\mu m \times \alpha L \times \frac{1}{BL}\right) \times 2$$

لايجاد B لازم اشتق وحدة من التنين $\left(\frac{\partial w}{\partial B} , \frac{\partial m}{\partial B}\right)$

بمساواة $WI = W.E$

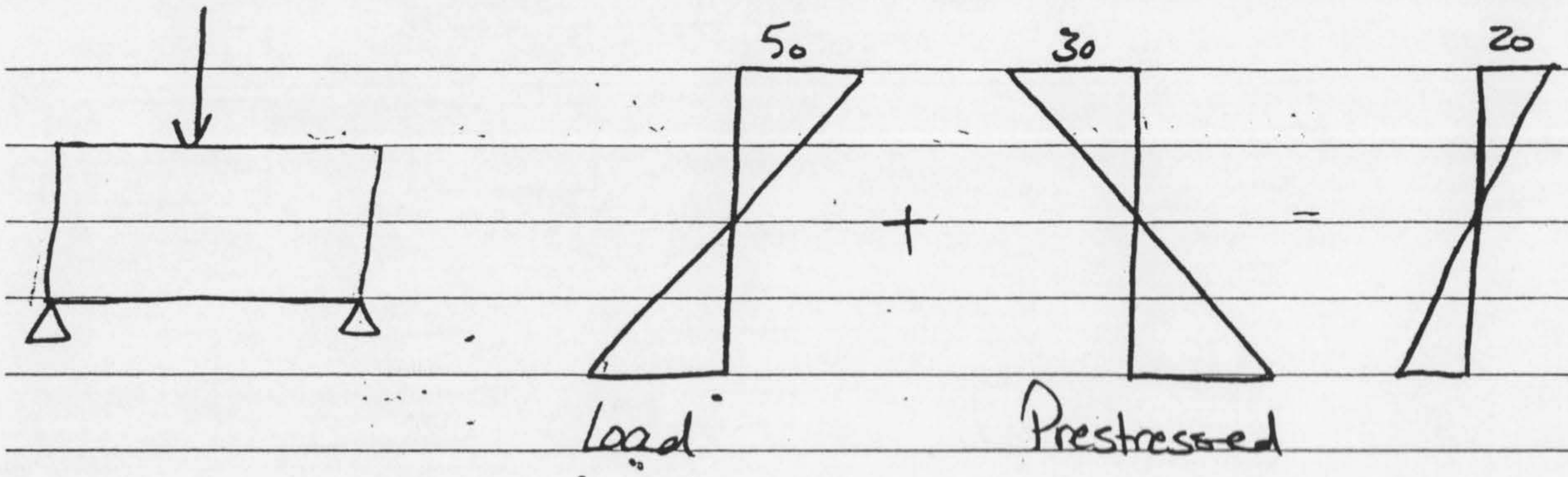
$$B = \frac{-4\mu\alpha^2 + \sqrt{16\mu^2\alpha^4 + 48\mu\alpha^2}}{8}$$ assum $\mu = 1$

$$B = \frac{-4\alpha^2 + \sqrt{16\alpha^4 + 48\alpha^2}}{8}$$

14/4/2016

الموضوع :   التاريخ :   /   / ٢٠١

Pre-Stressed Concrete (P.C) (ملزمة)



Pre-Stressed : عملية خلق اجهادات شبيهة بالاجهادات الناتجة من الاحمال ولكن بعكس الاشارة.

* نلاحظ من الرسم ان الـ Prestressed تحمله اقل من تحمل الـ load وهذا مهم بالـ tension حتى يقلل من الـ Crack.

Classification and Types

ⓐ → Exterally
→ Interally

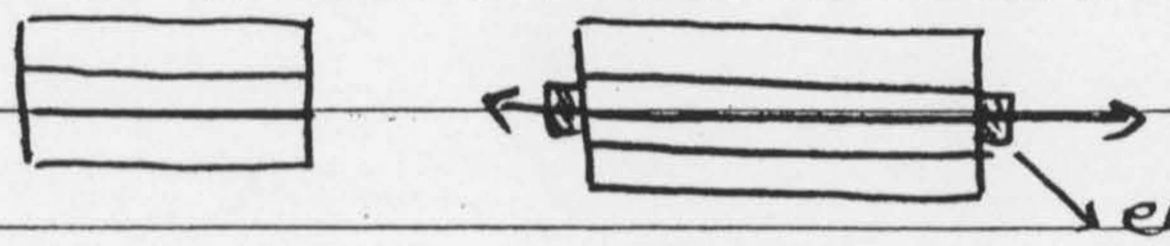
(b) → Linear ب Prestressed Tendon

→ Circular tank

مهم جداً

(c) → Pretensioning

تركـة ، تركيب كليه ، تشدة

→ Posttensioning 

Pressressed Steel

- wire
- cable
- bar
  - deformal
  - Plain
- Strand

(d) → End End Anchored
→ non End Anchored

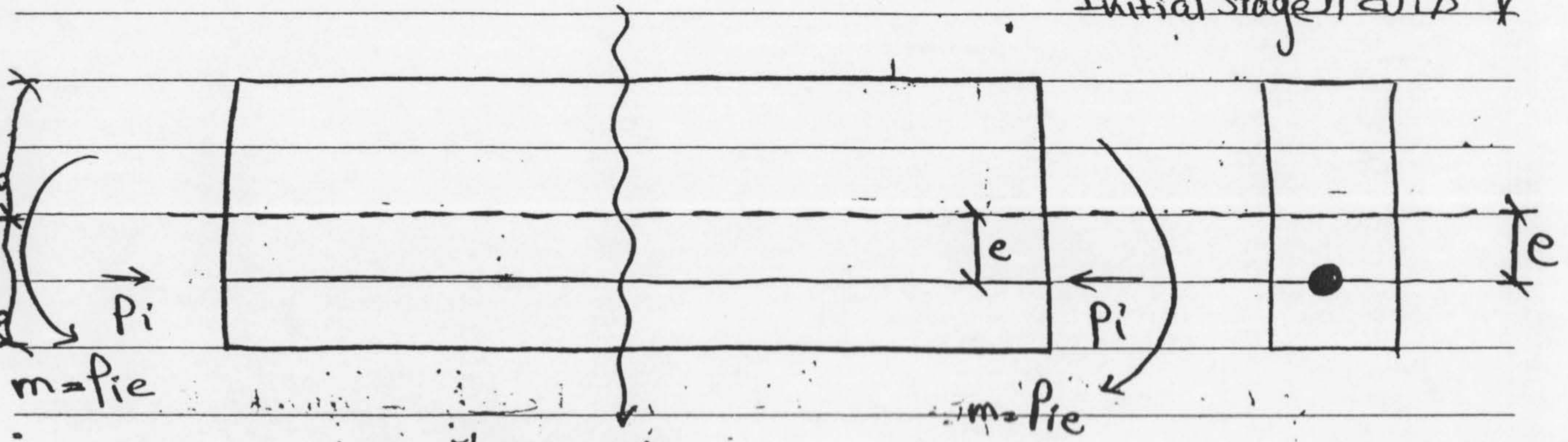
(e)

(F) → Precast
→ Cast in place
→ Composite   اكثر استخداماً.

(g) → Partially → هنا اكثر امان لان عند الثقل تتولد اجهادات غير متوقعة.
→ Fully

19 / 4 / 2016

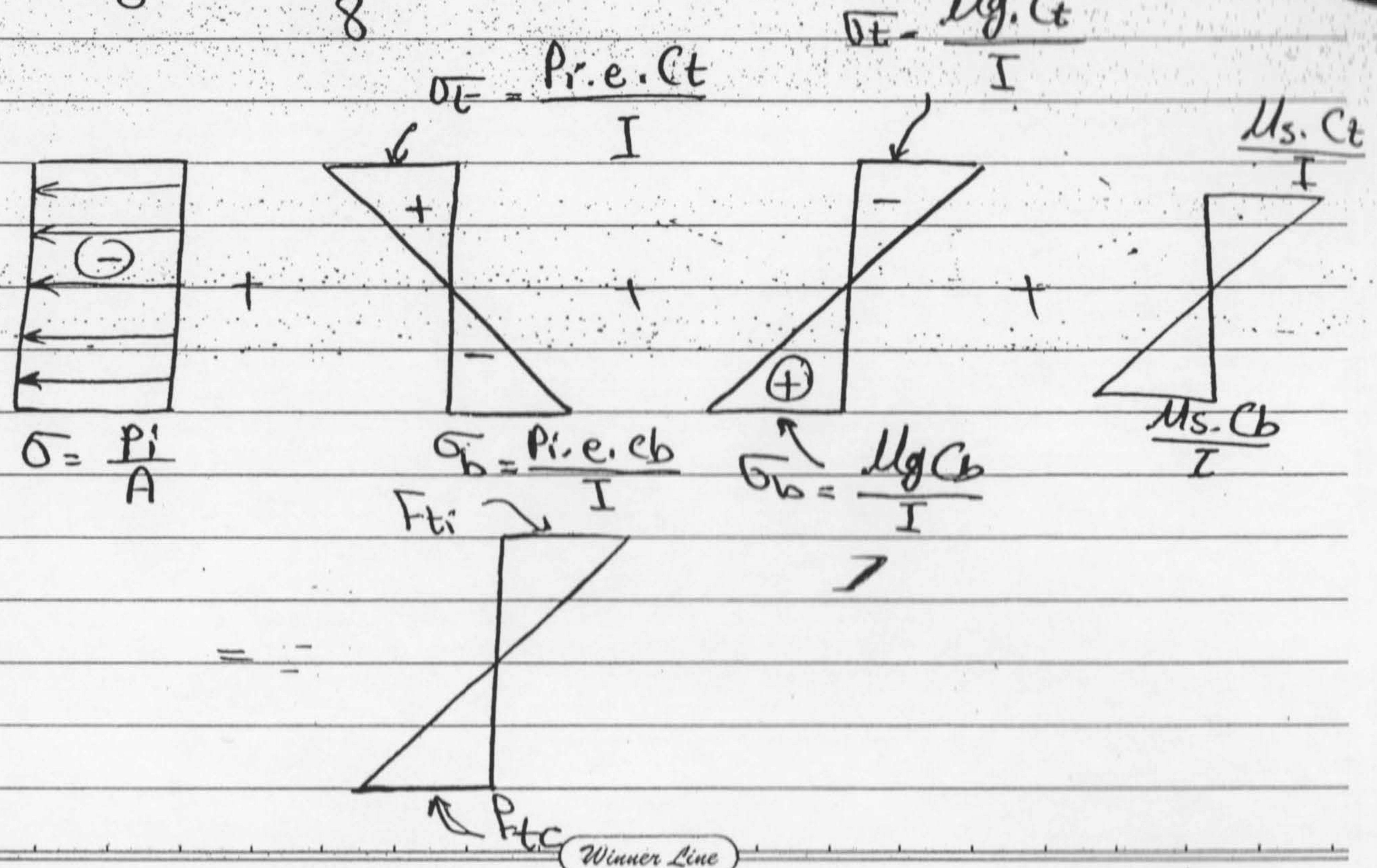
* حالة الـ Initial Stage



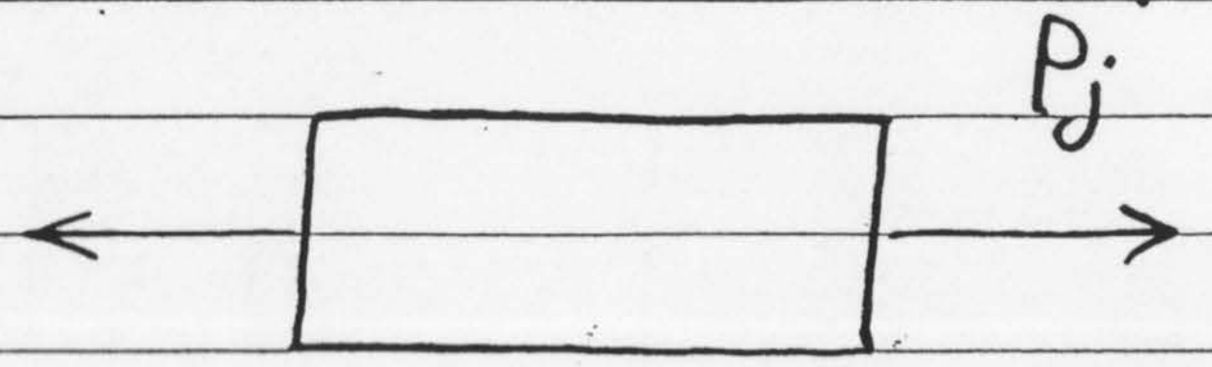
اذا احنا قطع هنا
تكون عندنا mg

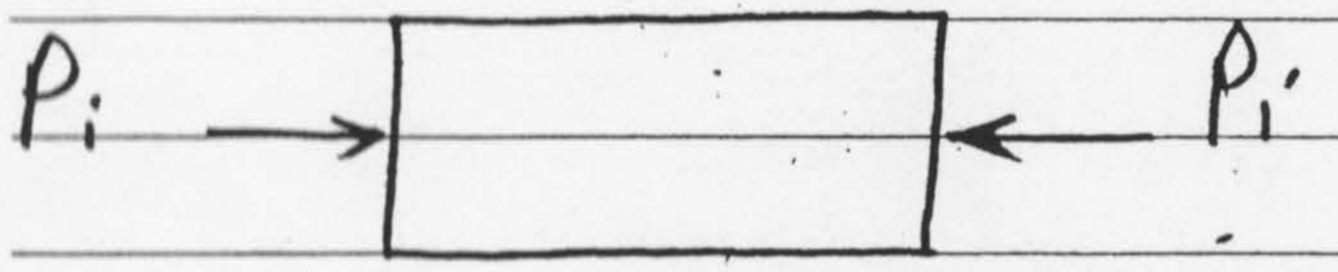
$$W_g =$$

$$M_g = \frac{w_g l^2}{8}$$

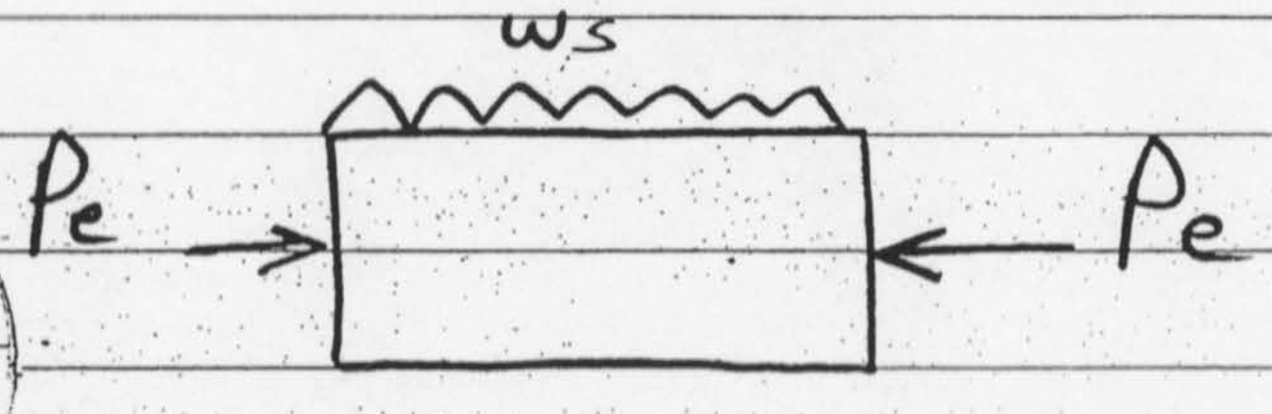


* * حالة السحب:

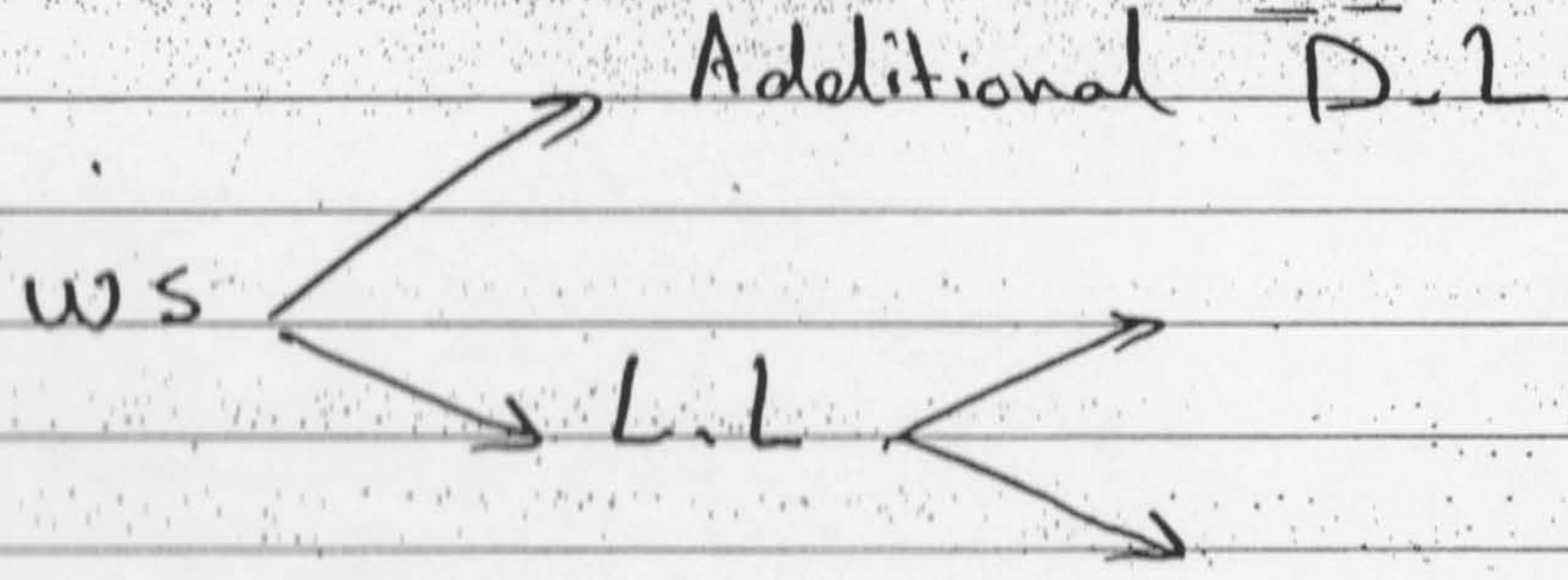




$P_i = P_j$ – Short term loss



$P_e = P_i$ – Long



Winner Line

ال Final نفس حجم ال initial بس نغير ال Pi بالمرة

Initial Stage

$$f_{ti} = \frac{-P_i}{A} + \frac{P_i . e . C_t}{I} - \frac{M_g . C_t}{I}$$

$$f_{bi} = \frac{-P_i}{A} - \frac{P_i . e . C_b}{I} + \frac{M_g C_b}{I}$$

** ونستطيع ان نحل المعادلات السابقة بدلالة
ال radius of gyration

$$r = \sqrt{\frac{I}{A}}$$

$$S_t = \frac{I}{C_t}$$

$$r^2 = \frac{I}{A}$$

$$S_b = \frac{I}{C_b}$$

$$I = r^2 A$$

$$f_{ti} = \frac{-P_i}{A}\left(1 - \frac{e C_t}{r^2}\right) - \frac{M_g}{S_t}$$

$$f_{bi} = \frac{-P_i}{A}\left(1 + \frac{e C_b}{r^2}\right) - \frac{M_g}{S_b}$$

$f_{ci} \leq 0.6\, f'_{ci}$

$f_{ti} = \leq \frac{\sqrt{f_{ci}}}{4}$ at Mid

$f_{ti} = \leq \frac{\sqrt{f_{ci}}}{2}$ at End

Final Stage

$$\left.\begin{aligned} f_{ts} &= \frac{-P_e}{A} + \frac{P_e e C_t}{I} - \frac{M_g C_t}{I} - \frac{M_s C_t}{I} \\ f_{bs} &= \frac{-P_e}{A} - \frac{P_e e C_t}{I} + \frac{M_g C_b}{I} - \frac{M_s C_b}{I} \end{aligned}\right\}$$

$r = \sqrt{\frac{I}{A}}$ $\qquad S_t = \frac{I}{C_t}$

$r^2 = \frac{I}{A}$ $\qquad S_b = \frac{I}{C_b}$

$I = r^2 A$

$$f_{ts} = \frac{-P_e}{A}\left(1 - \frac{e c_t}{r^2}\right) - \frac{M_g}{S_t} - \frac{M_s}{S_t} >$$

$$f_{ts} = \frac{-P_e}{A}\left(1 + \frac{e c_b}{r^2}\right) + \frac{M_g}{S_b} + \frac{M_s}{S_b}$$

$f_c \leq$ 0.45 f_c' of sustained load
0.6 f_c' of total load

$$f_{ti} = \leq \frac{\sqrt{f_c'}}{2}$$

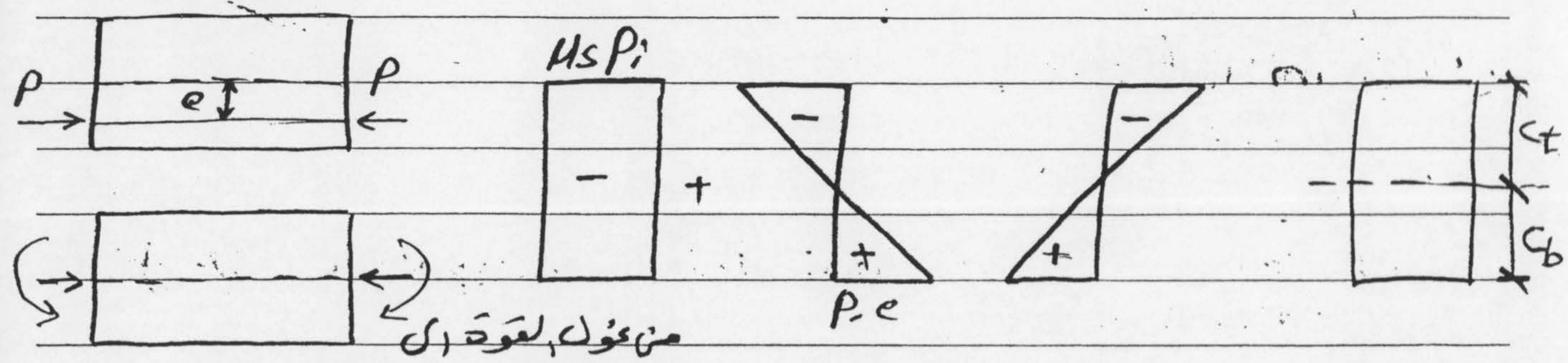
Stress in initial = min $\begin{bmatrix} 0.82\ f_y \\ 0.7\ f_y \end{bmatrix}$

- 25/4/2016 -

الموضوع :   التاريخ / / ٢٠١

مراجعة

Initial



من تحول القوة الى
السنترلاين يصبح معها عزم

$$f_{top\,i} = \frac{-P_i}{A} + \frac{P_i \cdot e \cdot C_t}{I} - \frac{M_g \cdot C_t}{I}$$

$$= \frac{-P_i}{A}\left(1 - \frac{e \cdot C_t}{r^2}\right) - \frac{M_g}{S_t}$$

S_t → elastic modulus.

$$f_{bottom\,i} = \frac{-P_i}{A} - \frac{P_i \cdot e \cdot c_t}{I} + \frac{M_g \cdot C_b}{I}$$

$$= \frac{-P_i}{A}\left(1 + \frac{e\,C_b}{r^2}\right) + \frac{M_g}{S_t}$$

$$r^2 = \frac{I}{A}$$

** بالزوايات عدنة بس
فيكون Comp.
$M_g = 0$

$$I = r^2 A$$

allowable Stress

① Initial Stage

Ⓐ Compression

i) f_{ci} (compression) $\leq 0.6\ F_{ci}$ كل مكان عدا النهايات

ii) $f_{ci} \leq 0.7\ F_{ci}$ at End of support

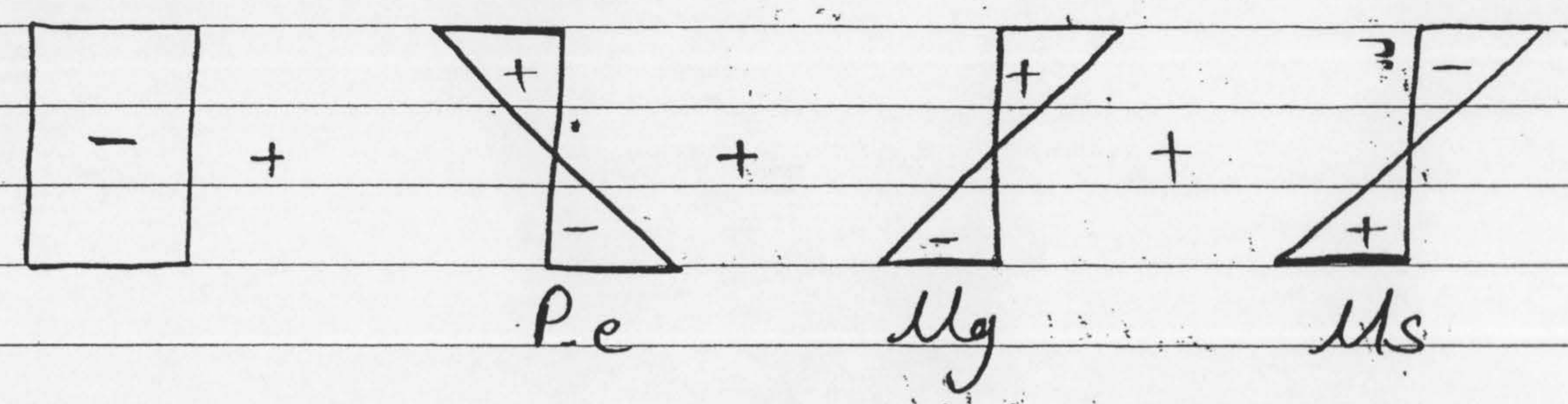
Ⓑ Tension

i) f_{ti} (tension) $\leq \frac{\sqrt{F_{ci}}}{4}$ بكل مكان

ii) $f_{ti} \leq \frac{\sqrt{F_{ci}}}{2}$ at end of support

Service load
- → additional load
- → Live load
  - → Sustained
  - → non-sustained

final (Service)



$$f_{top\ service} = \frac{-P_e}{A} + \frac{P_e . e . C_t}{I} - \frac{M_g . C_t}{I} - \frac{M_s . C_t}{I}$$

$$= \frac{-P_e}{A}\left(1 + \frac{e c_b}{r^2}\right) - \left(\frac{M_g + M_s}{S_b}\right)$$

$$F_{bottom\ service} = \frac{-P_e}{A}\left(1 + \frac{e . C_b}{r^2}\right) + \left(\frac{M_g + M_s}{S_b}\right)$$

(2) At final stage (Service Stage)

(A) $f_{comp.} \leqslant (0.45 f_c')$ due sustain load + Pre-Stress load.

$(0.6\ f_c')$ due to total load.

(B) tension

$f_t \leqslant 0.62 \sqrt{f_c'}$

Ex8

$I = 469 * 10^9$ mm^4

$A_c = 110 * 10^3$ mm^2

$r^2 = 42.6 * 10^3$ m^2

$S = 15.63 * 10^6$ mm^3

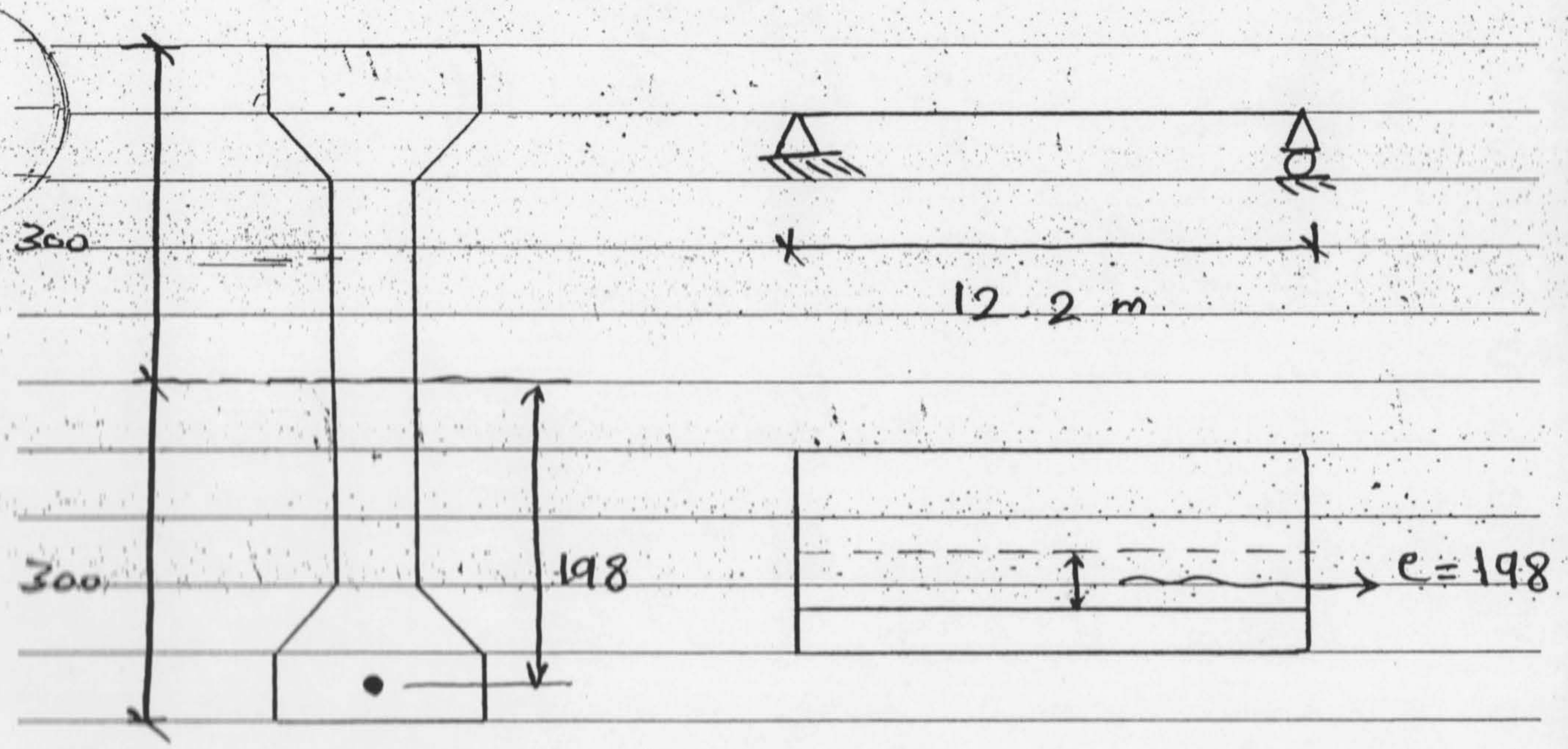
$w_g = 2.64$

$w_{s\,total} = 11$ KN/m

$w_{sustain} = 5$ KN/m

$P_i = 703$ KN

$P_e = 596$ KN



Checking stress of beam at end and mid span at initial stage and final stage.

$f_{ci} = 26$, $F_c' = 35$

Sol

① Initial Stage

ⓐ at end of support

$$f_{top\,i} = \frac{-703 * 10^3}{110 * 10^3}\left(1 - \frac{198 * 300}{42.6 * 10^3}\right) = +2.52$$

(عشري comp وزارية) $\frac{\sqrt{f_{ci}}}{2}$ نقارنها مع ال

$$2.52 < \frac{\sqrt{26}}{2} = 2.549$$

$$f_{bottom\,i} = \frac{-703 * 10^3}{110 * 10^3}\left(1 - \frac{198 * 300}{42.6 * 10^3}\right) = -15.3$$

$$15.3 \leq 0.7\, f_{ci} = 18.2$$

(Tension عشري وزارية)

OK

Ⓑ At mid span

$$M_g = \frac{2.64 * 12.22^2}{8} = 49.1 \text{ kN.m}$$

$f_{top\,i} = +2.52 - \frac{49.1 * 10^6}{15.63 * 10^3}$

$= +2.52 - 3.14 = -0.63$

لازم نقارن (عدد comp وبالـ mid) $< 0.6\,f_{ci} = 0.6 * 26 = 15.8$

$f_{bottom} = -15.3 + 3.14 = -12.16$

(2) Final Stage

(A) At end of support

$f_{top\,service} = 2.52 \times \frac{596}{703}$

(نتعامل بالحل على الـ initial)

$= +2.15 < 0.62\sqrt{f_c'} = 3.6679$

$f_{bottom\,service} = -15.3 * \frac{596}{703} = -12.97$

$< 0.45\,f_c' = 15.7$

بالنهايات لازم نقارن بالـ 0.45 f_c'

١٨٠

Ⓑ at mid span

$$M_{sustain+g} = \frac{(2.62+5) * 12.2^2}{8} = 141.7\ KN.m$$

$$M_{s+g\ \text{total top}} = \frac{(2.64+11) * 12.2^2}{8} = 253.4\ KN.m$$

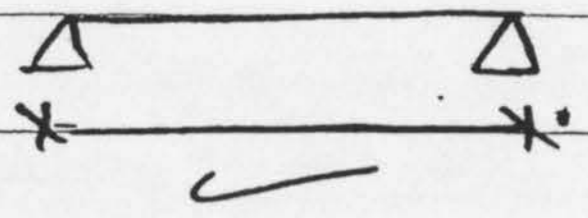
$$f_{top_s\ \text{due sustainload}} = +2.15 - \frac{141.7 * 10^6}{15.63 * 10^6} = -6$$

$$+2.15 - 9.094 = -6.95 < 0.45 f_c' = 15.75$$

$$f_{top\ s\ \text{due to total load}} = +2.15 - \frac{253.4 * 10^6}{15.63 * 10^3} = -14.1 < 0.6 f_c' = 21$$

$$f_{bottom_s} = -12.97 + \frac{253.4 * 10^6}{15.63 * 10^6} = 3.266$$

اسئلة فاينل ^^



$e =$ ✓

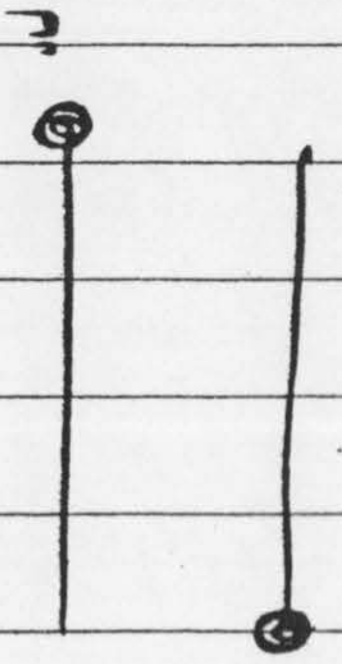
$C_t =$ ✓

$C_b =$ ✓

$P_i =$ ✓

$P_e =$

S_t, S_b



$A =$ ✓

$\gamma_c = 25$

$I =$ ✓

$L.L =$ ✓

(A) Top fiber $= 0$ at (beam weight pluse prestress force)

Initial يعني

$$M_g = \frac{w_g\, l^2}{8}$$

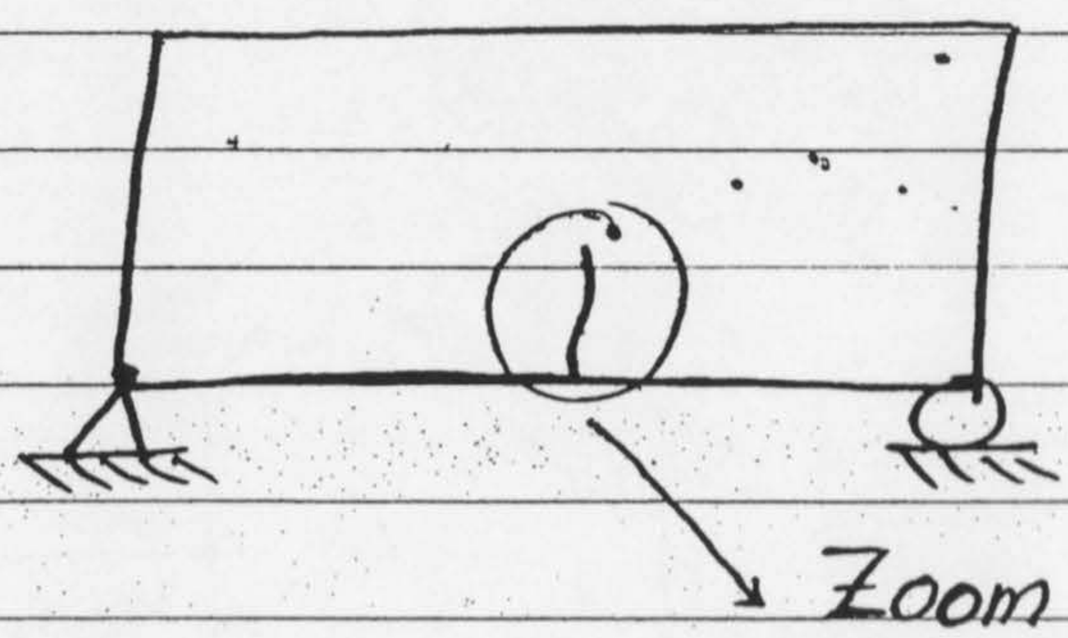
$$w_g = A * 25$$

(B) bottom fiber $= 0$ under full load

$(w_s + w_g)$

"Serviceability" — صلاحية الاستخدام

① Cracking width Control.
② Deflection Control.



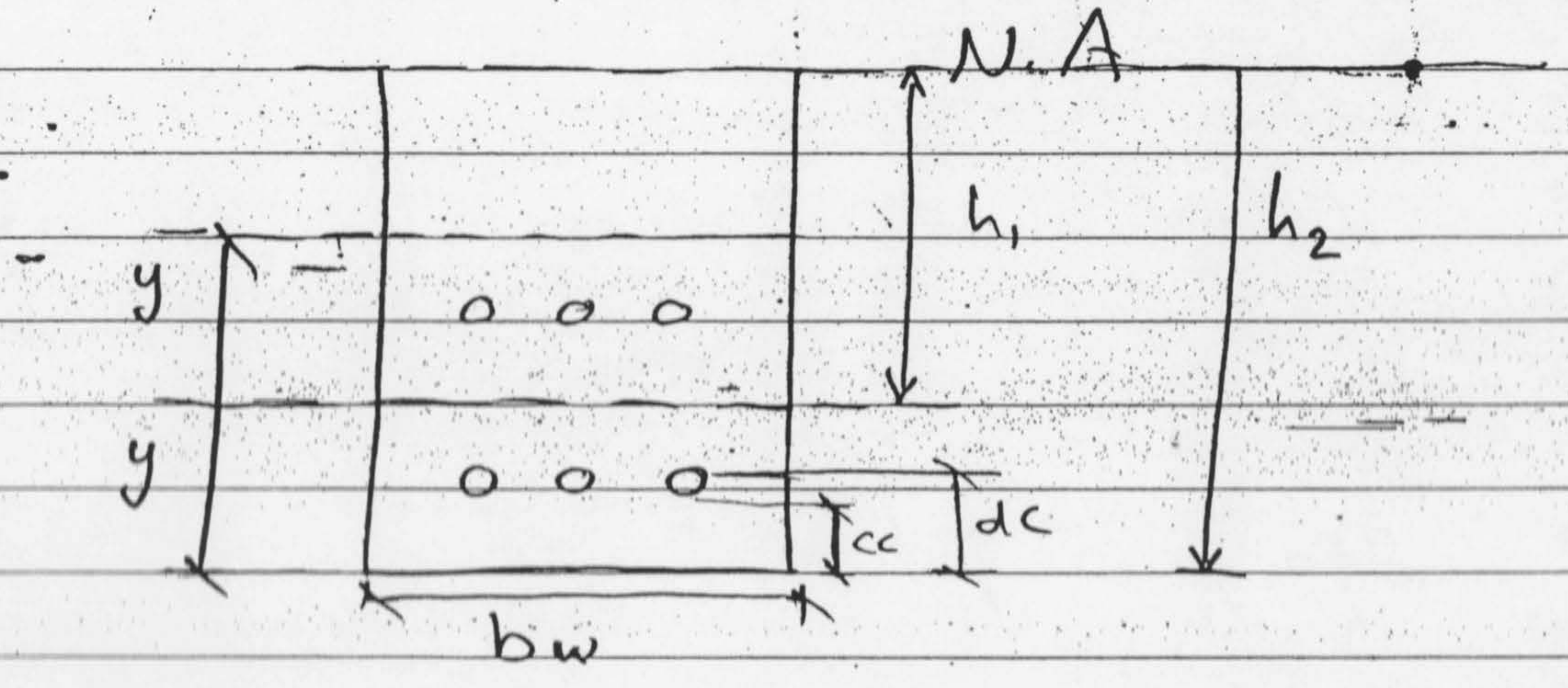
$$\omega = 1.1\, \beta^{3}\sqrt{d_c A}$$

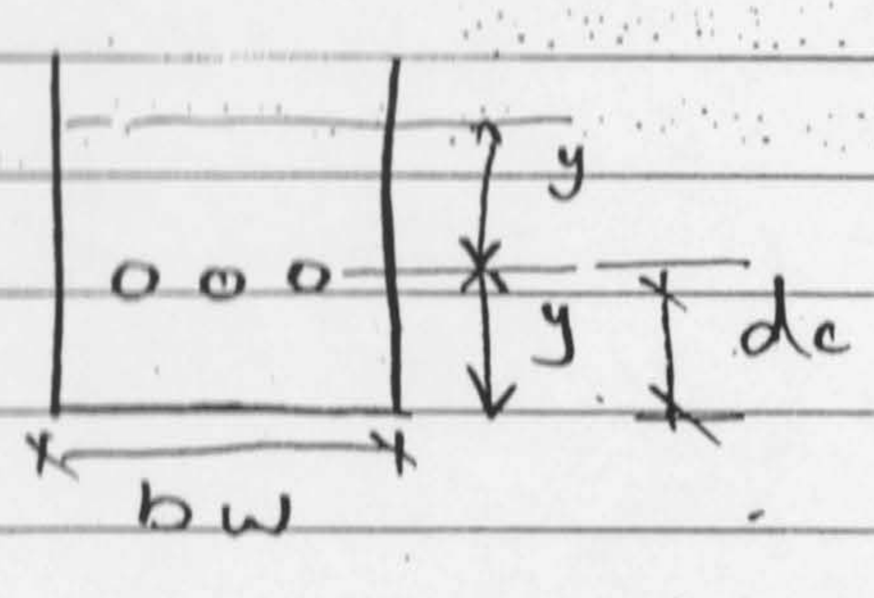
$$\omega = 2\,\frac{f_s}{E_s}\,\beta\,\sqrt{d_c^{2} + \left(\frac{S}{2}\right)^{2}}$$

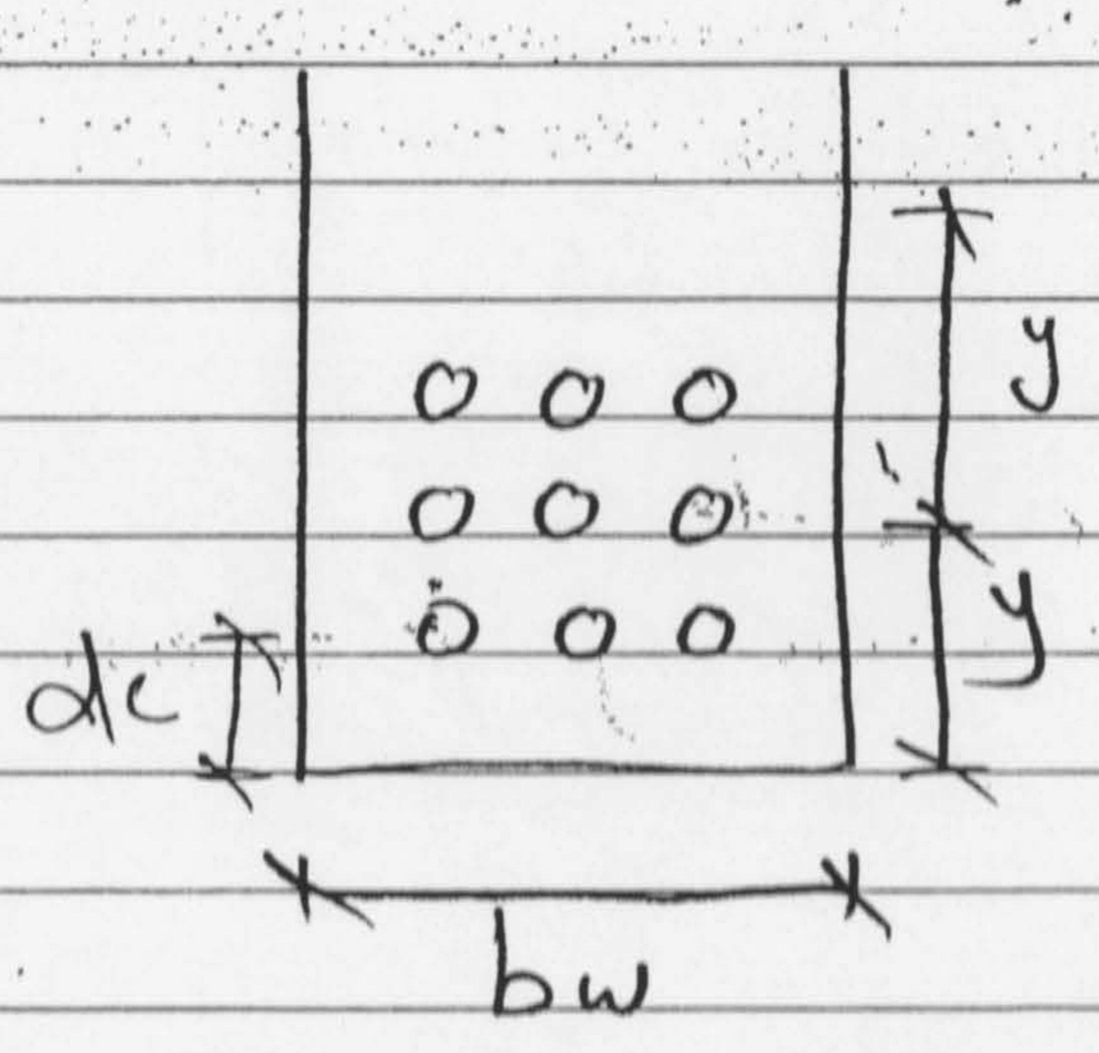
ACI code
S: spacing between bar C/C

$$S \leq S_{max} = \min \begin{cases} 380\left(\frac{280}{F_s}\right) - 2.5\,C_c \\ 300\left(\frac{280}{F_s}\right) \end{cases}$$

$$F = n\,\frac{M_c}{I_{ct}} \simeq \frac{2}{3} F_y$$







$$A = \frac{2y \times b_w}{\text{No. of bars}}$$

الموضوع :   التاريخ / / ٢٠١

$$A = \frac{2y * bw}{\text{no. of bars}}$$